



FDOT

Post-Tensioning Policy

Flexible Filler Implementation Update

Rick W. Vallier, P.E.

FDOT Structures Design Engineer

Outline

- ☐ Structures Manual
- ☐ Design Standards
- ☐ Specifications
- ☐ Research

Structures Manual & Design Standards

FLORIDA DEPARTMENT OF TRANSPORTATION



FDOT STRUCTURES MANUAL

Volume 1 - Structures Design Guidelines

Volume 2 - Structures Detailing Manual

Volume 3 - Modifications to LTS-6

Volume 4 - Fiber Reinforced Polymer Guidelines

[Frequently Asked Questions](#)

[2016 Revision History](#)

[Archived Structures Manuals](#)

[Additional Links](#)



Vol. 1 - SDG 1.11.1(B)
“Design and detail all
tendons with flexible
filler to be unbonded
and **fully replaceable.**”



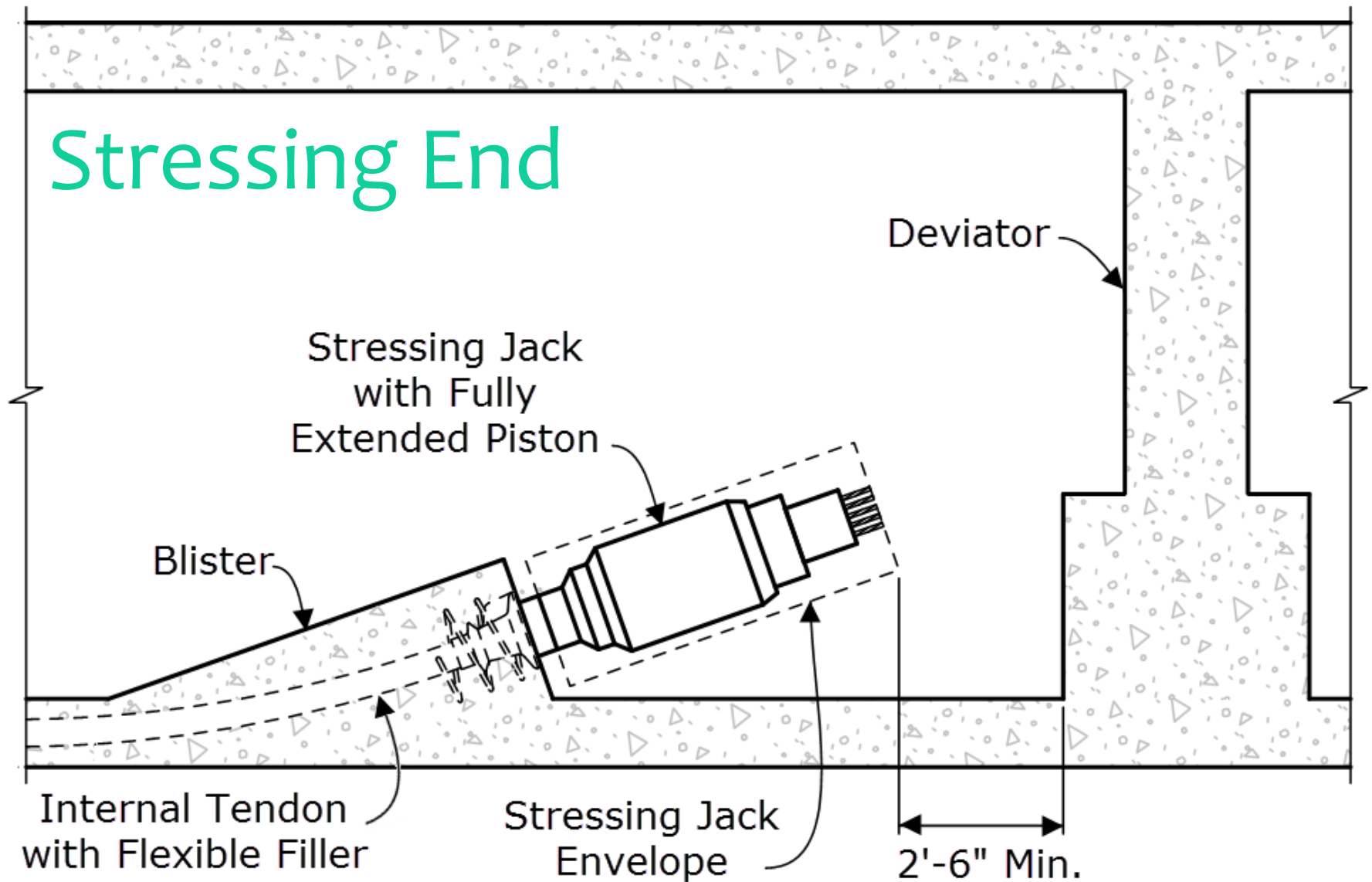
Vol. 1 - SDG 1.11.1(B)
“Design and detail all tendons with flexible filler to be unbonded and **fully replaceable.**”

Stressing End



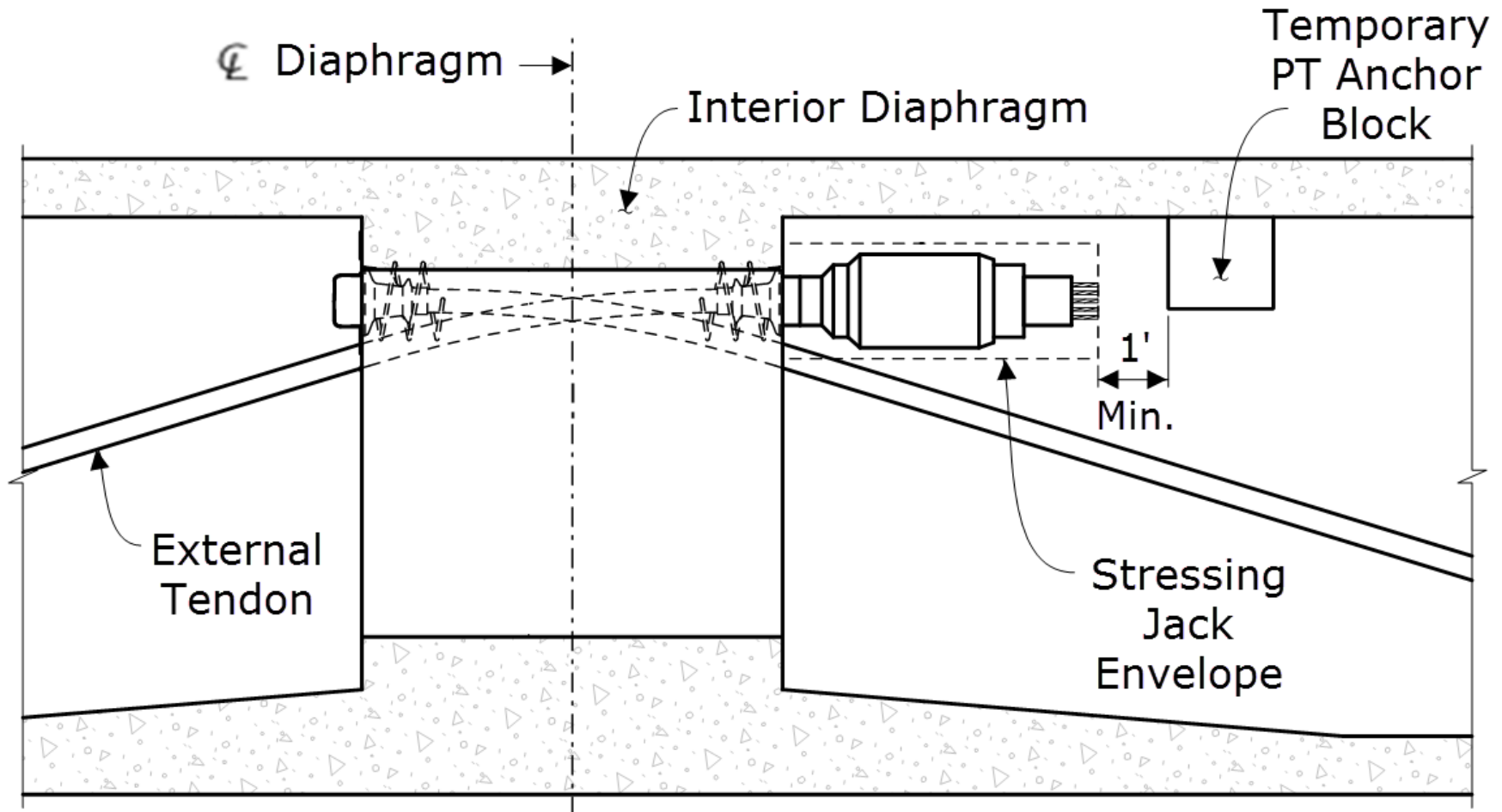
Stressing Jack
Envelope

Stressing End



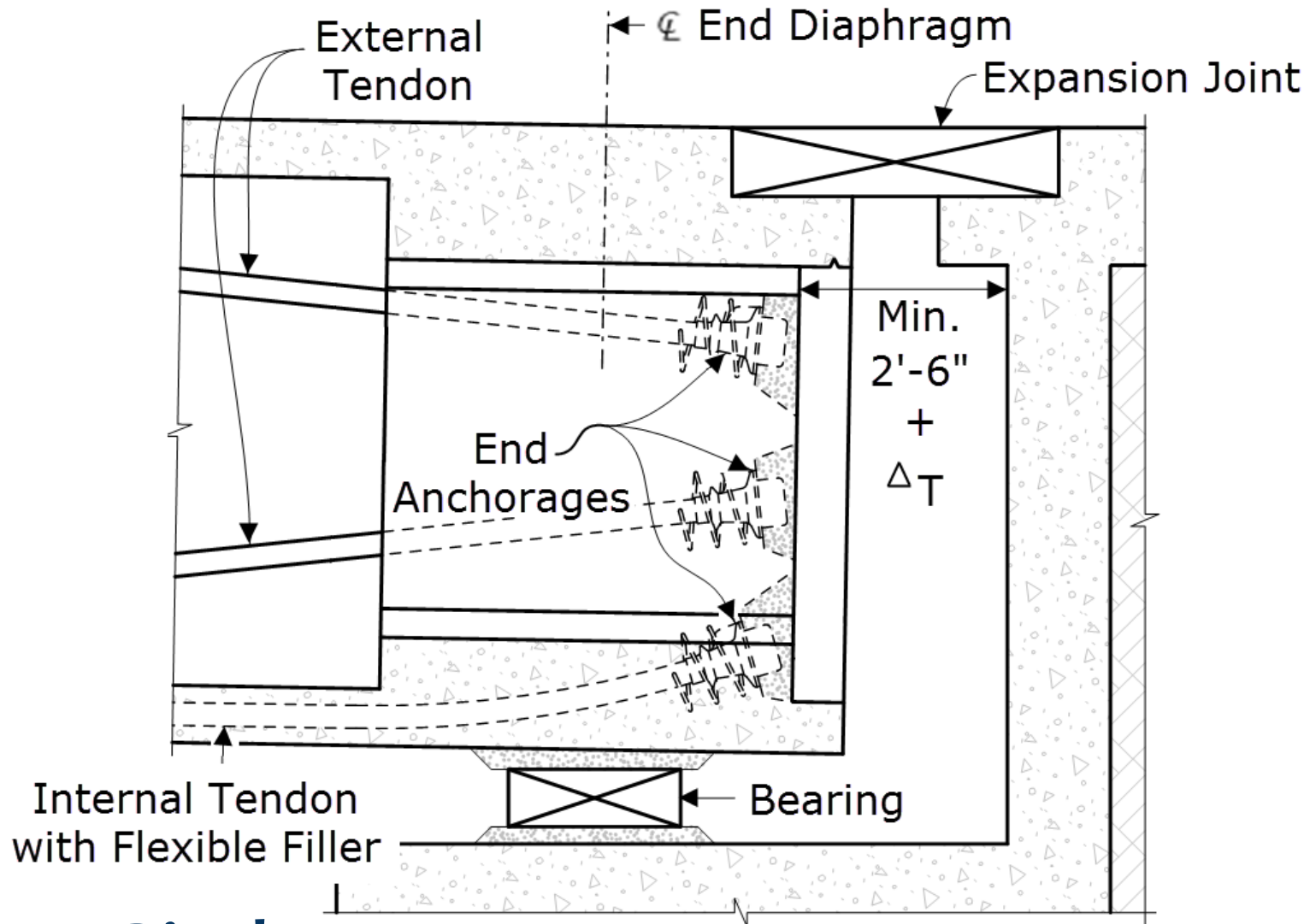
Box Girder

Stressing End



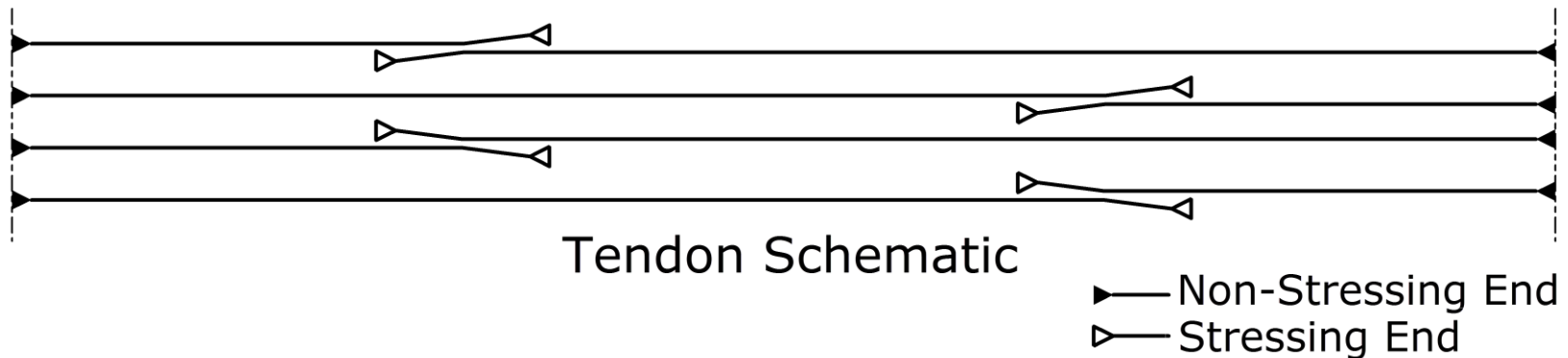
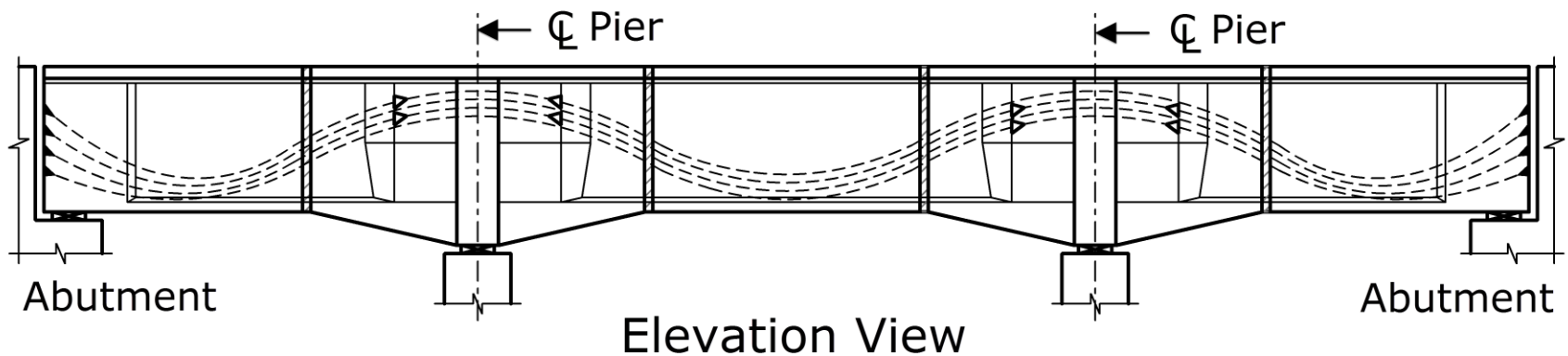
Box Girder

Non-Stressing End



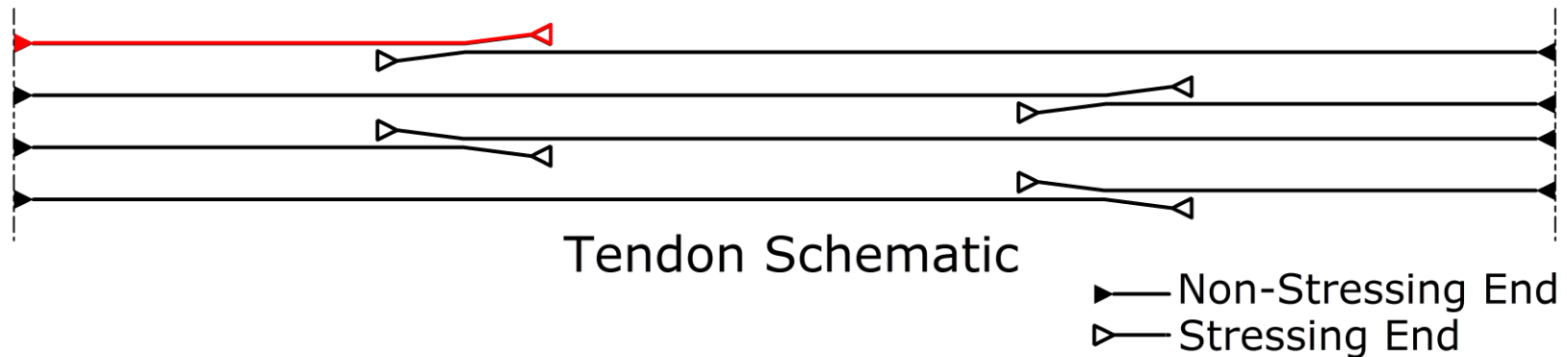
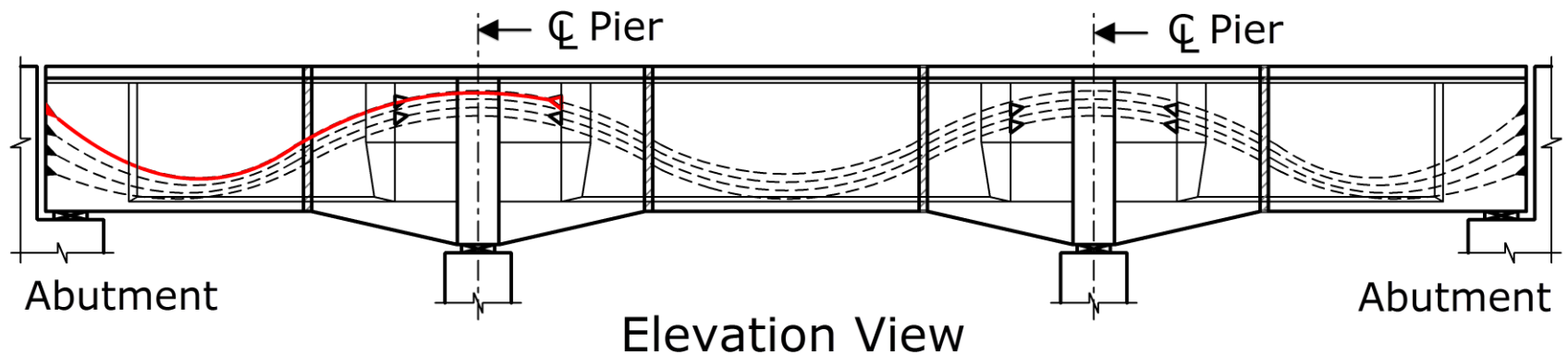
Box Girder

Tendon Replacement



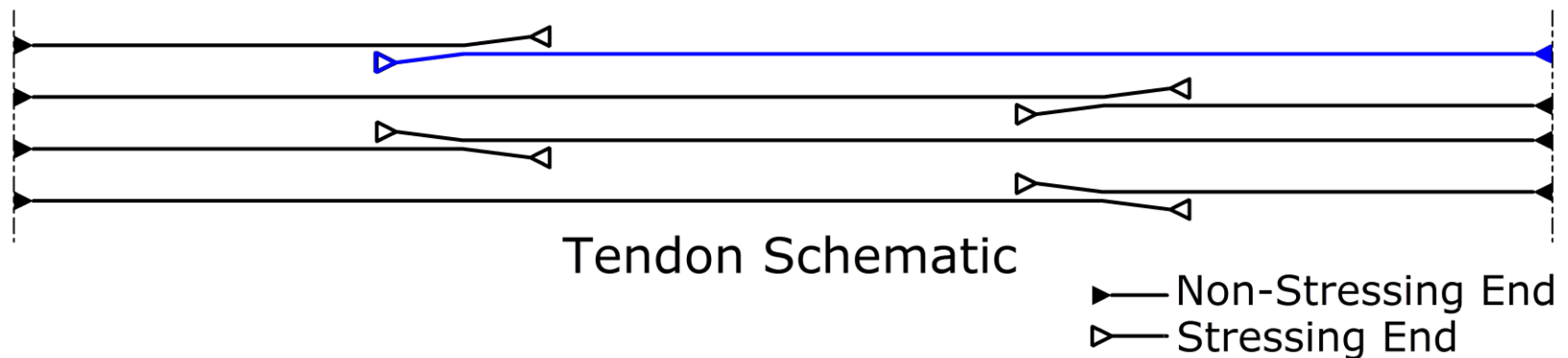
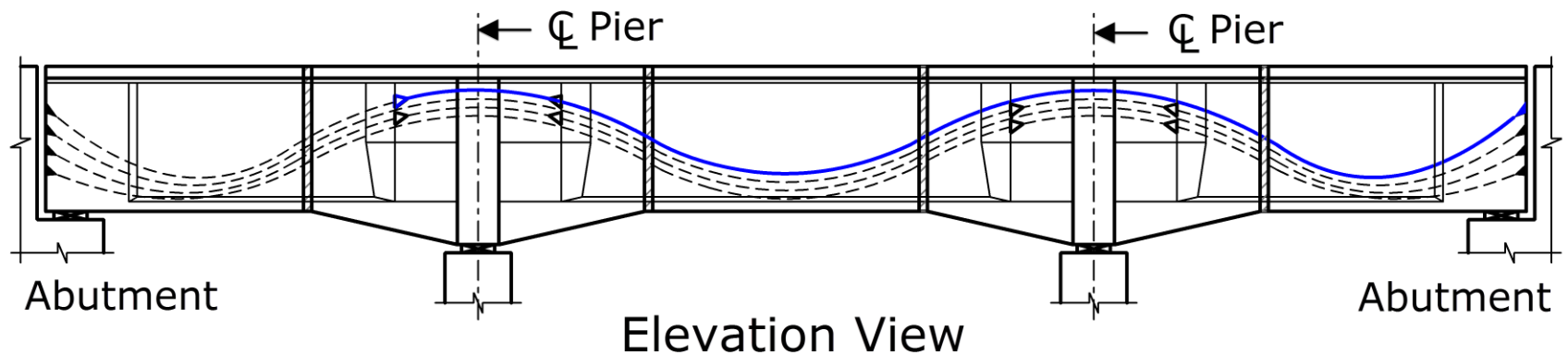
Spliced I-Girder

Tendon Replacement



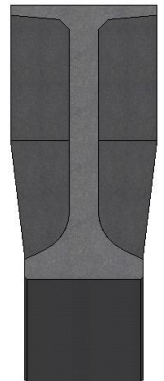
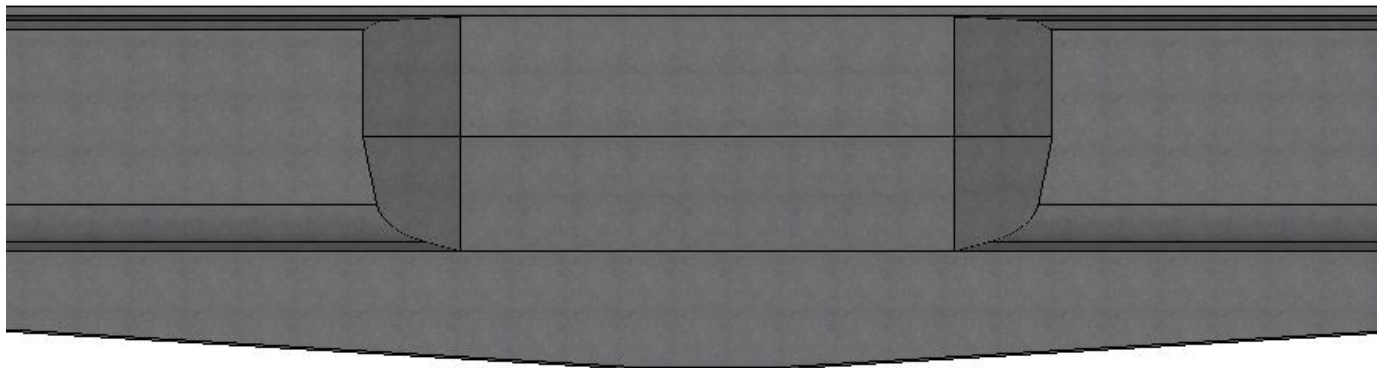
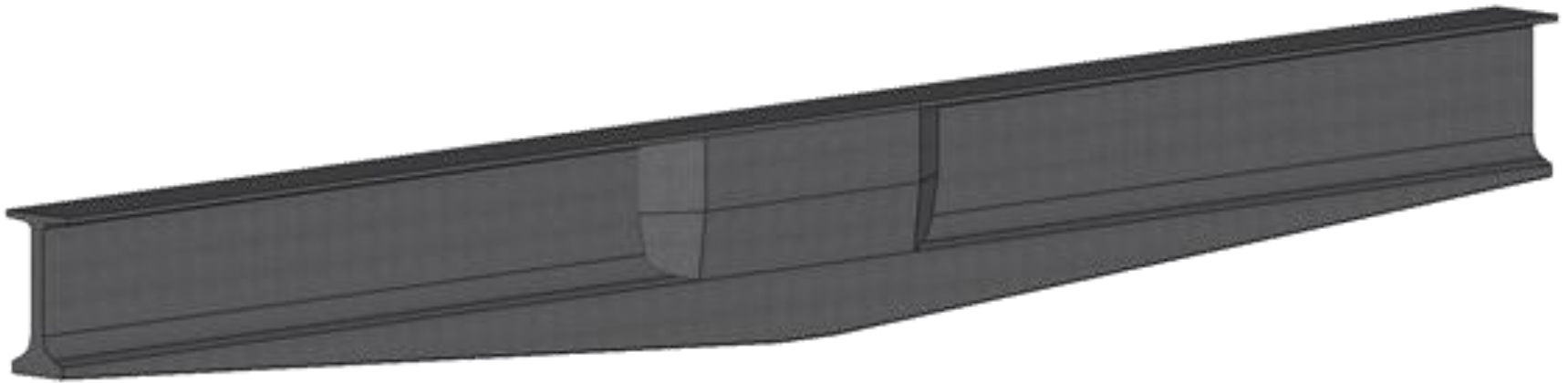
Spliced I-Girder

Tendon Replacement



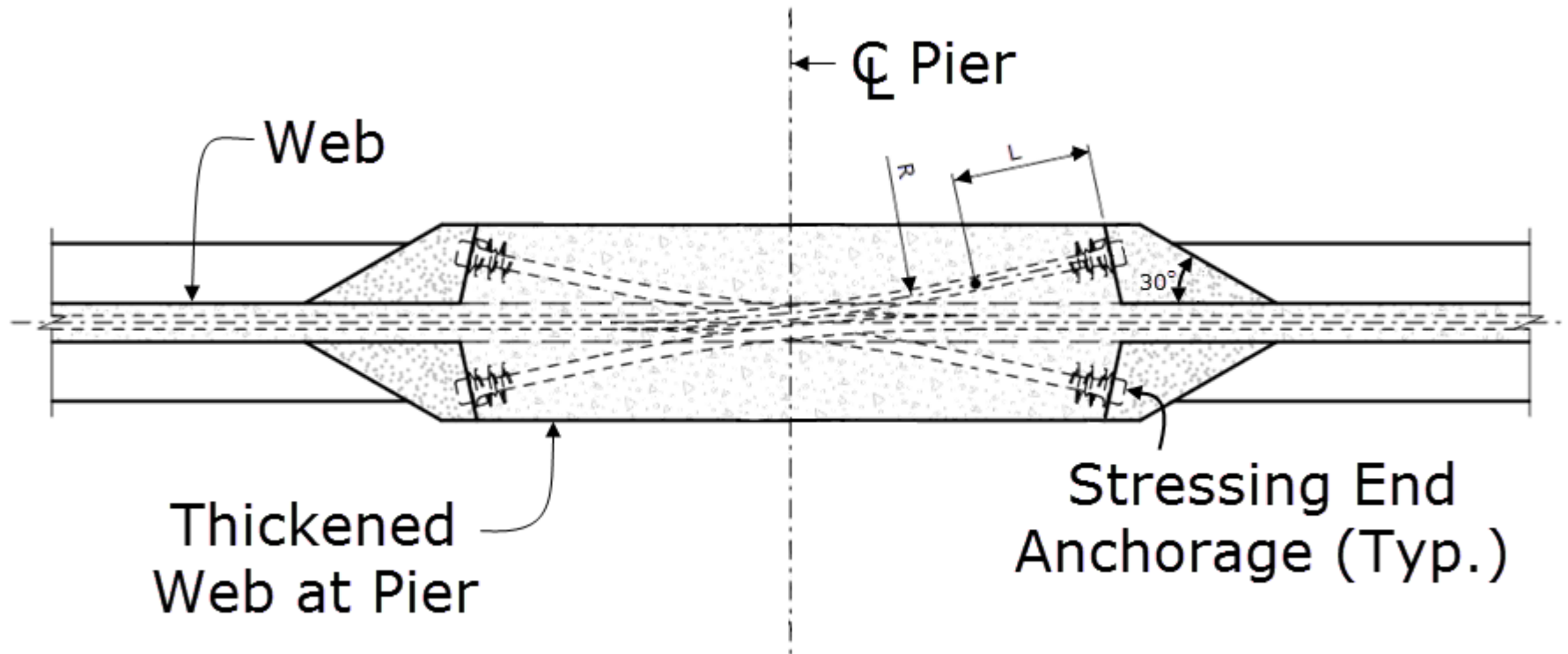
Spliced I-Girder

Thickened Web



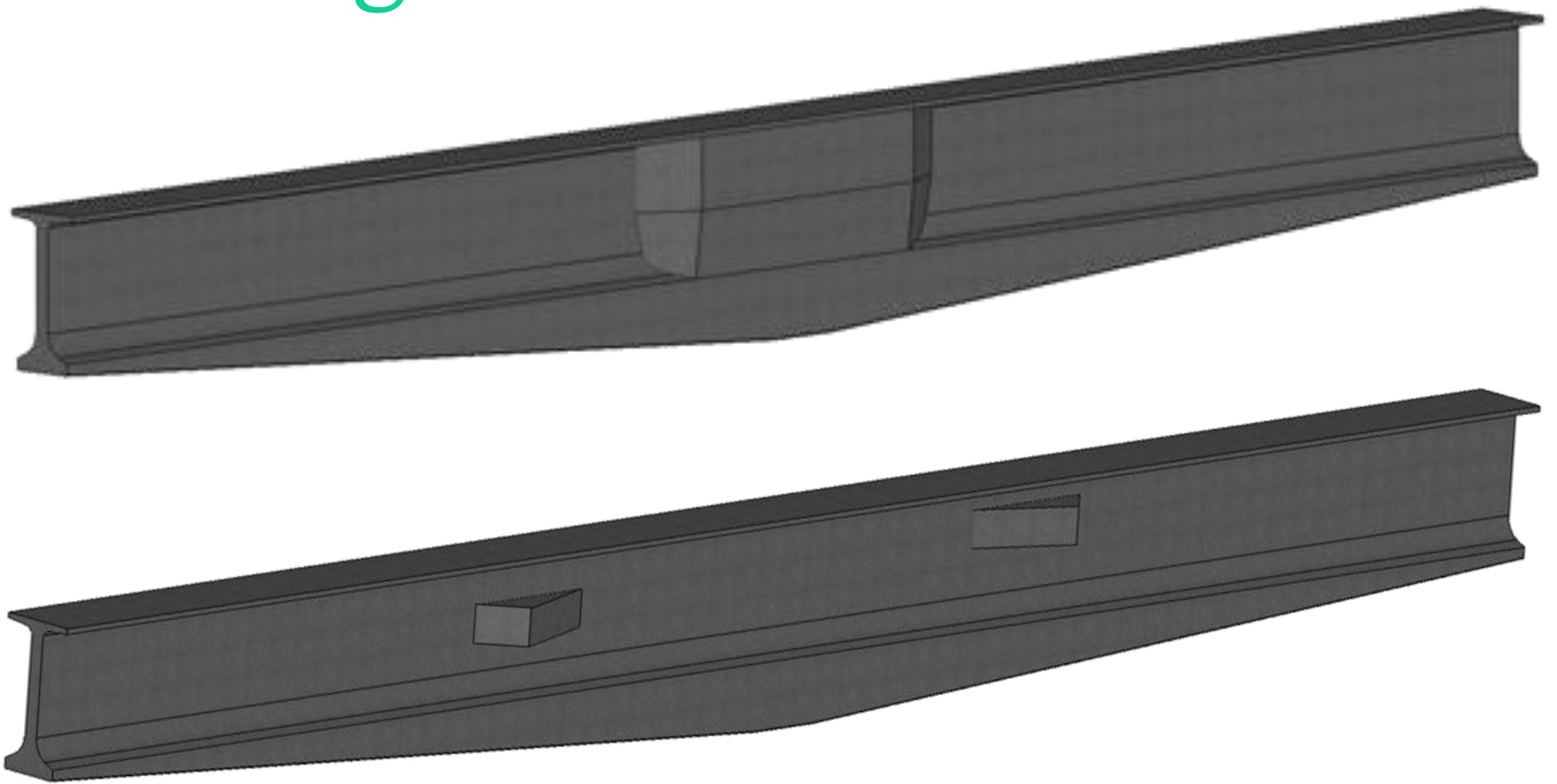
Post-Tensioned I-Beam

Stressing End at Thickened Web



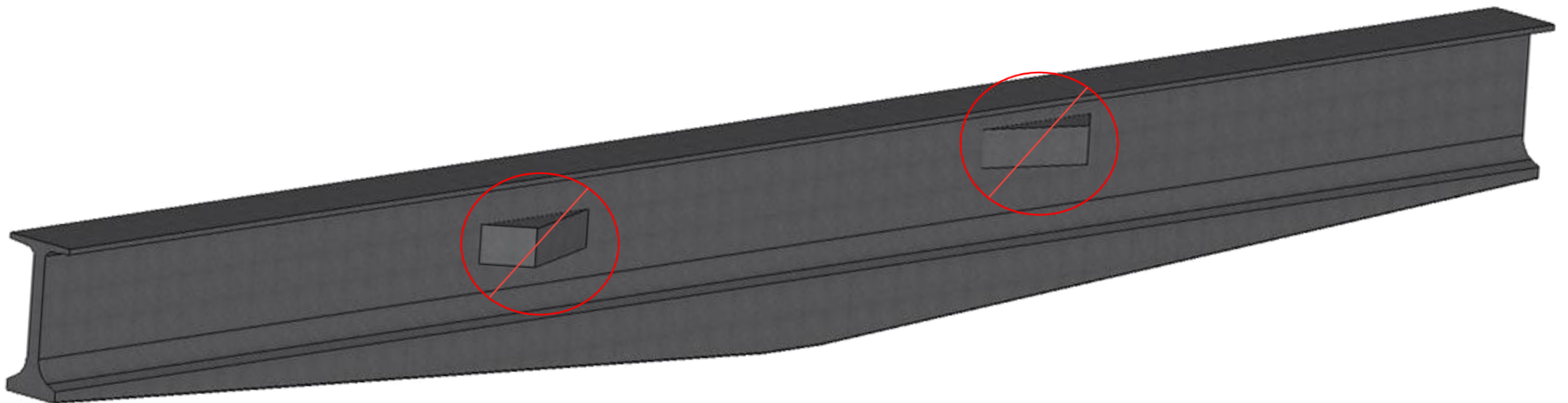
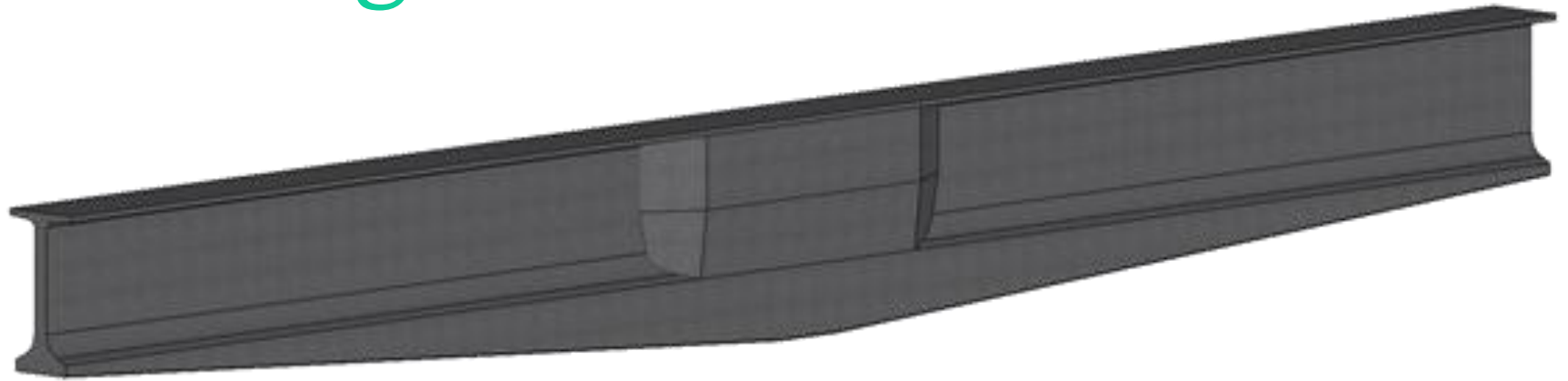
Post-Tensioned I-Beam

Stressing End



Post-Tensioned I-Beam

Stressing End

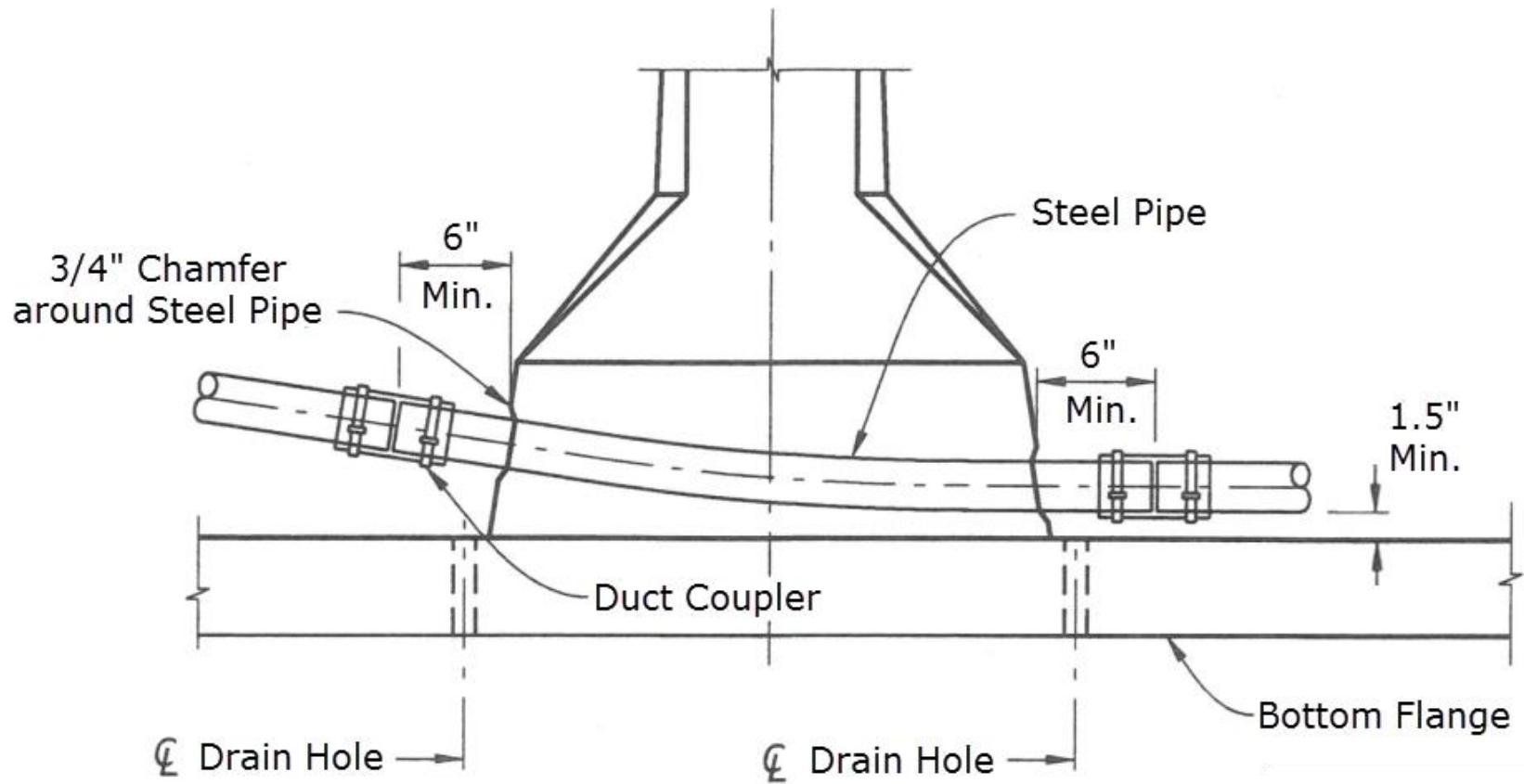


Post-Tensioned I-Beam

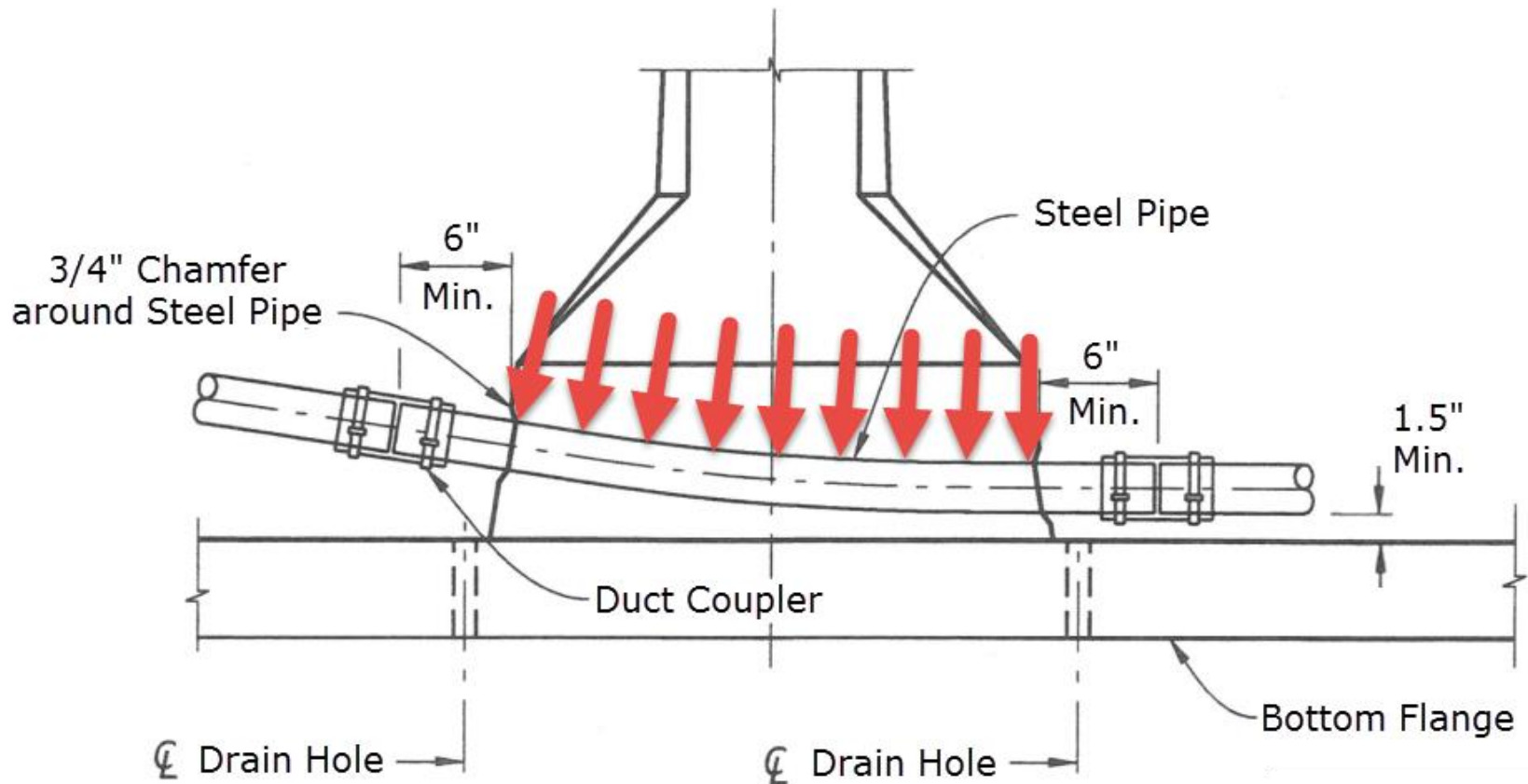
Spliced I-Girder



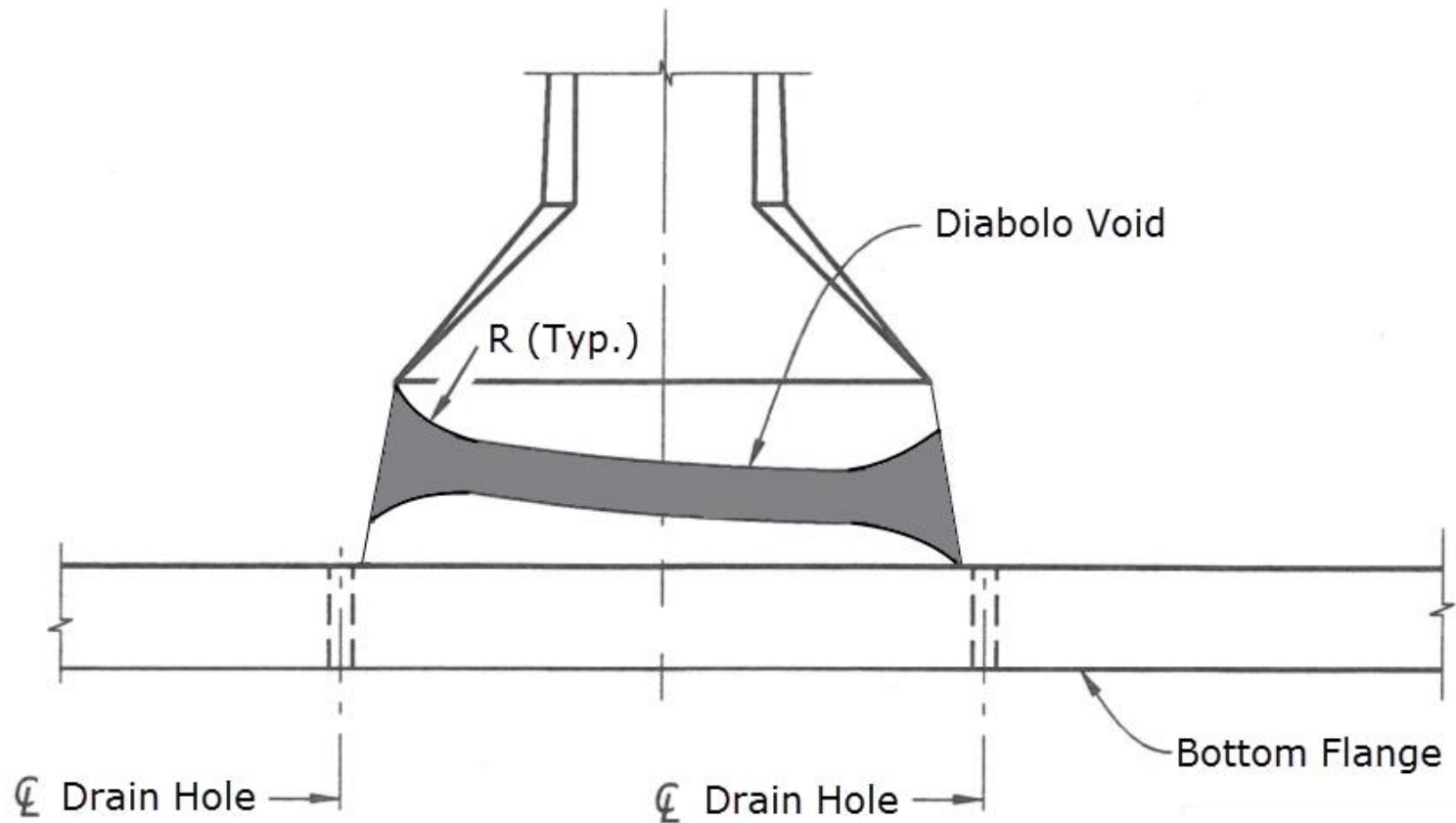
Conventional Deviator Detail



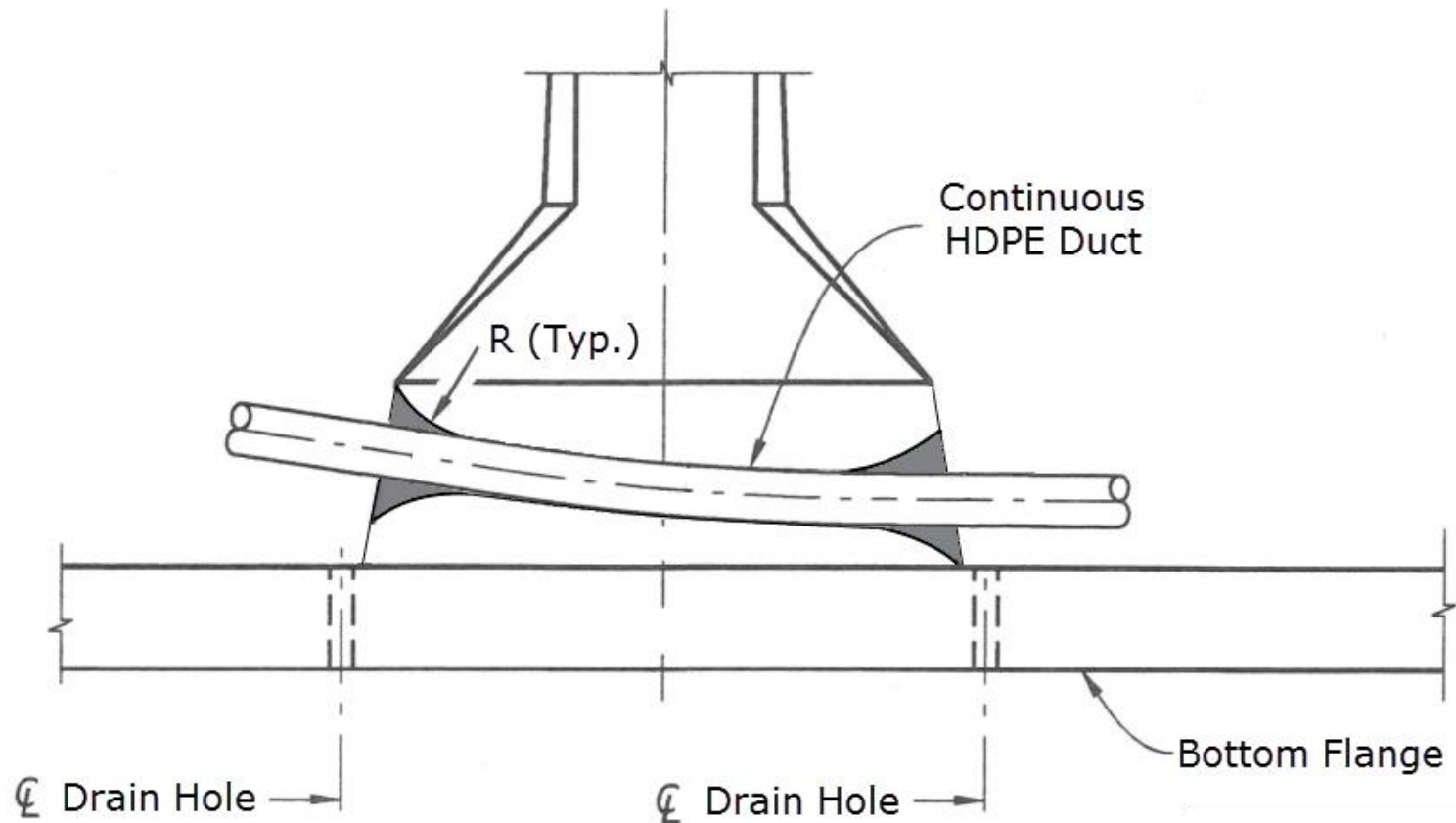
Steel Pipe Deviator Detail



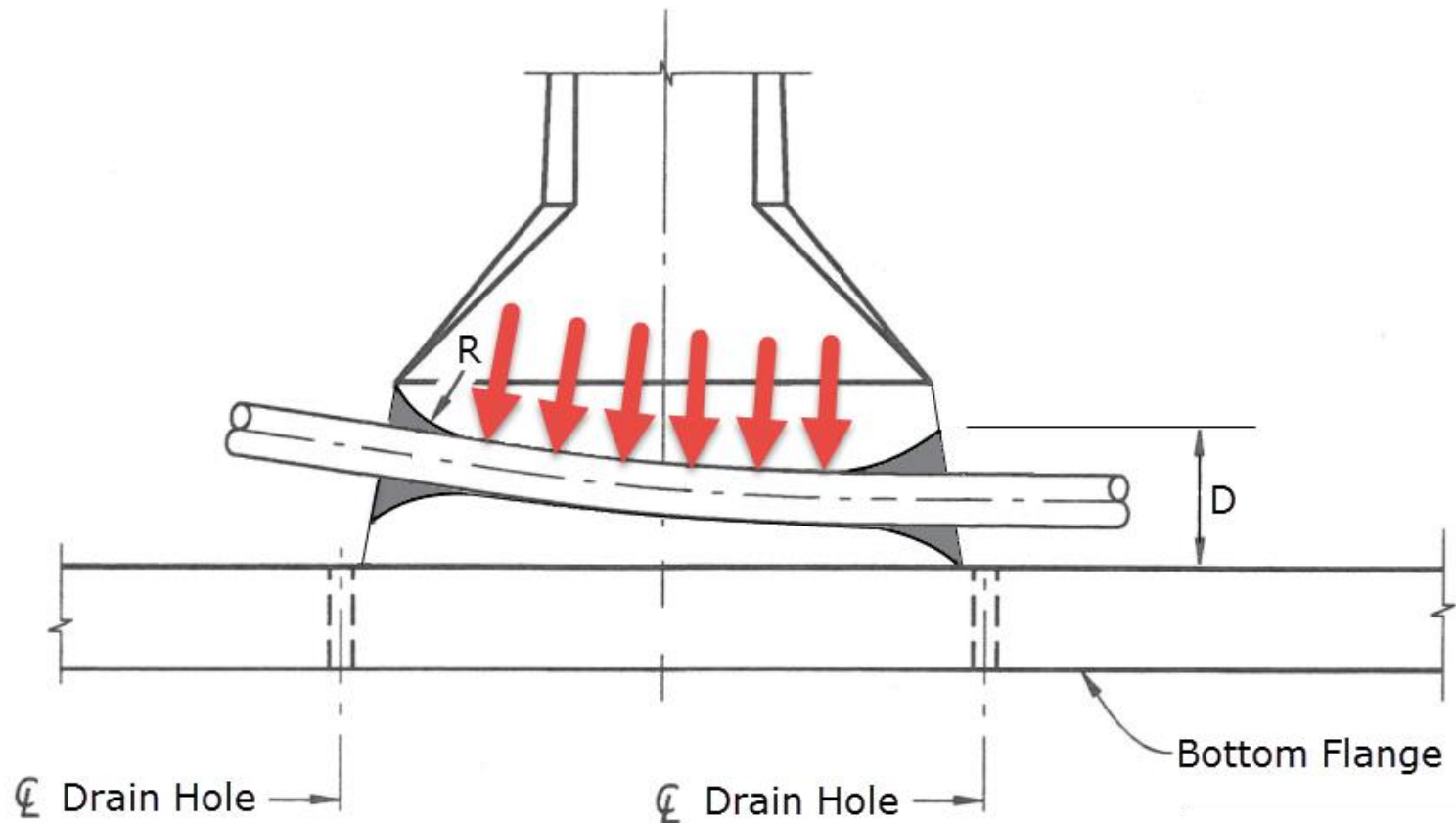
Diabolo Void



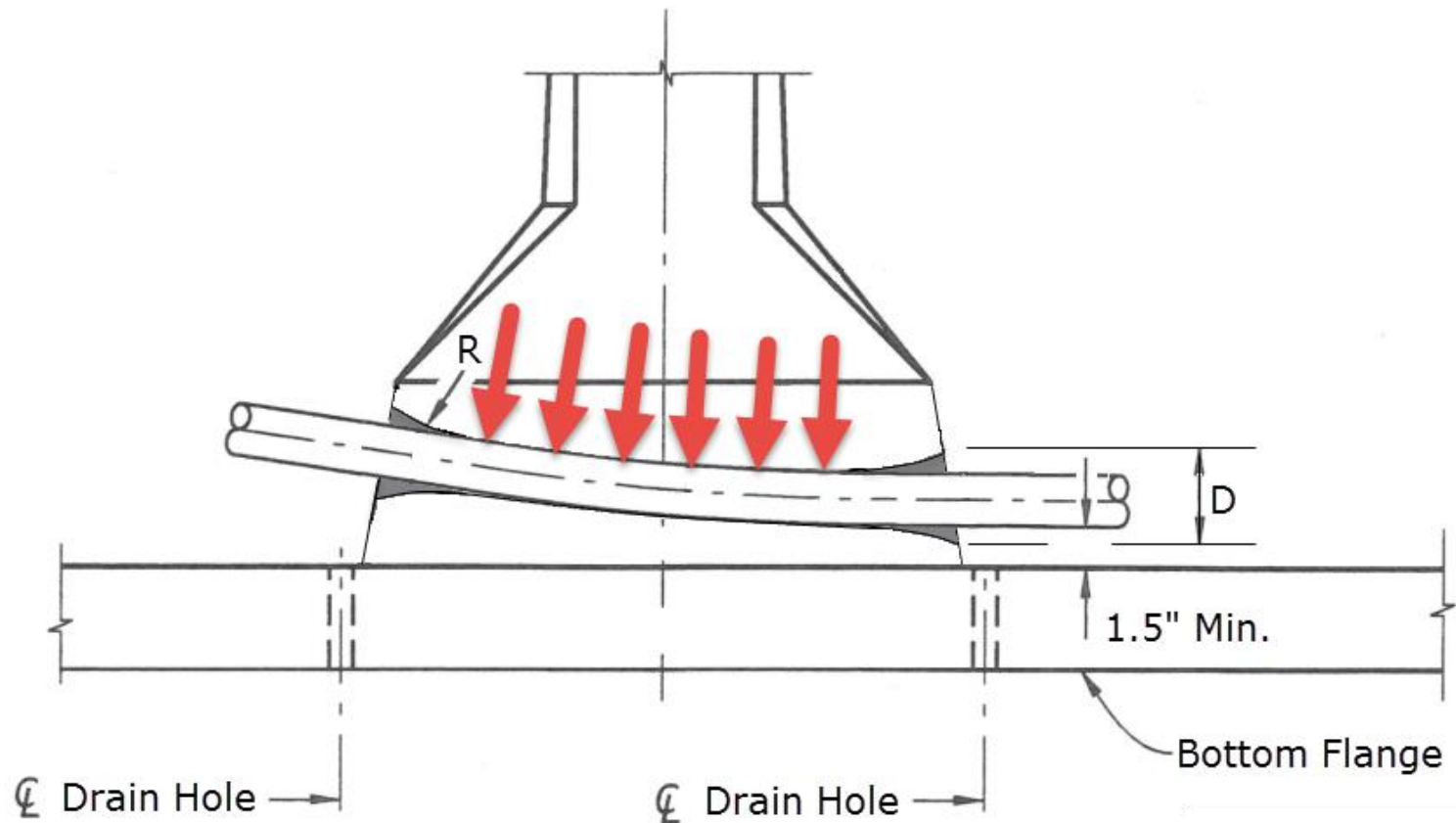
Diabolo Deviator With HDPE Duct



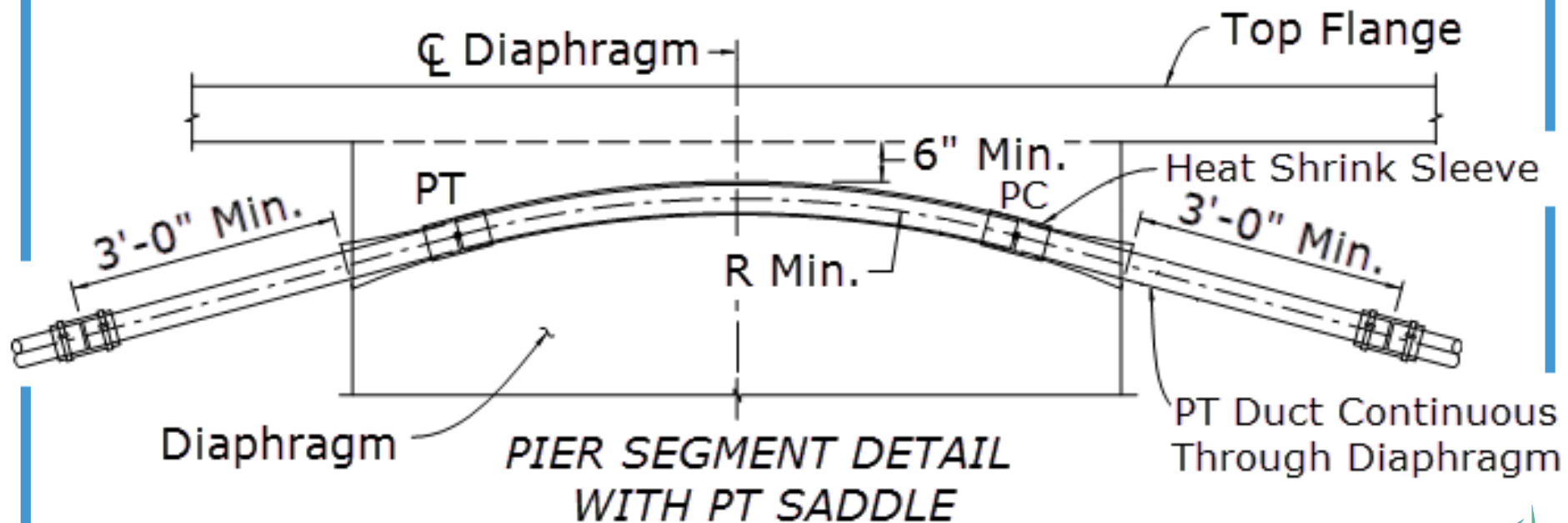
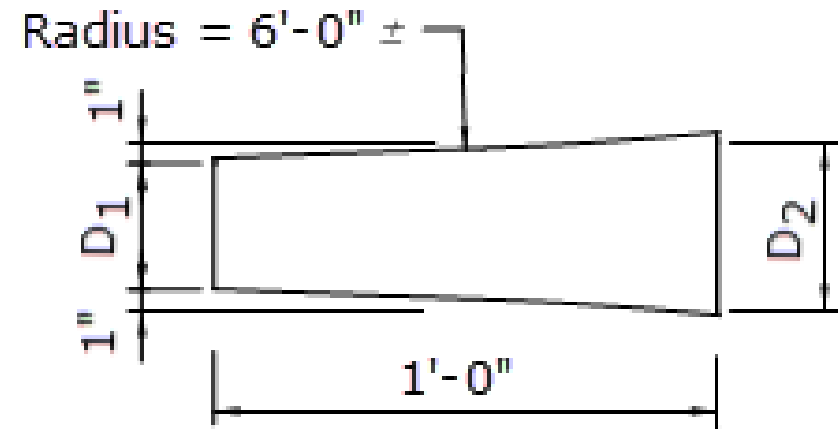
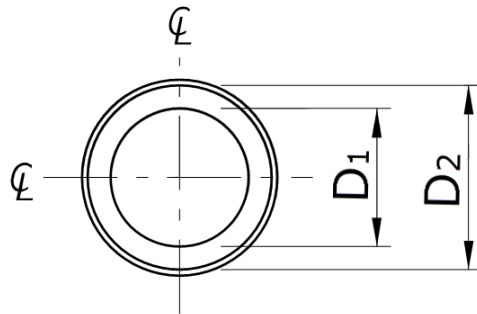
Diabolo Deviator With HDPE Duct



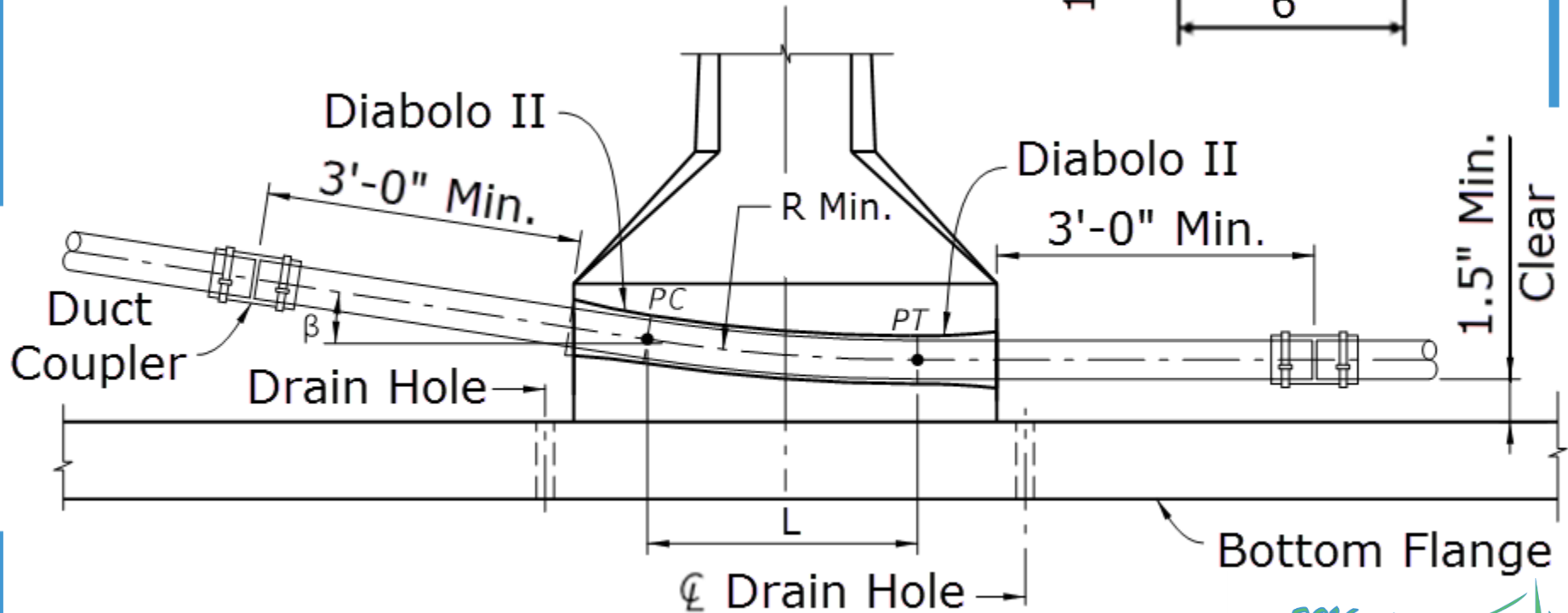
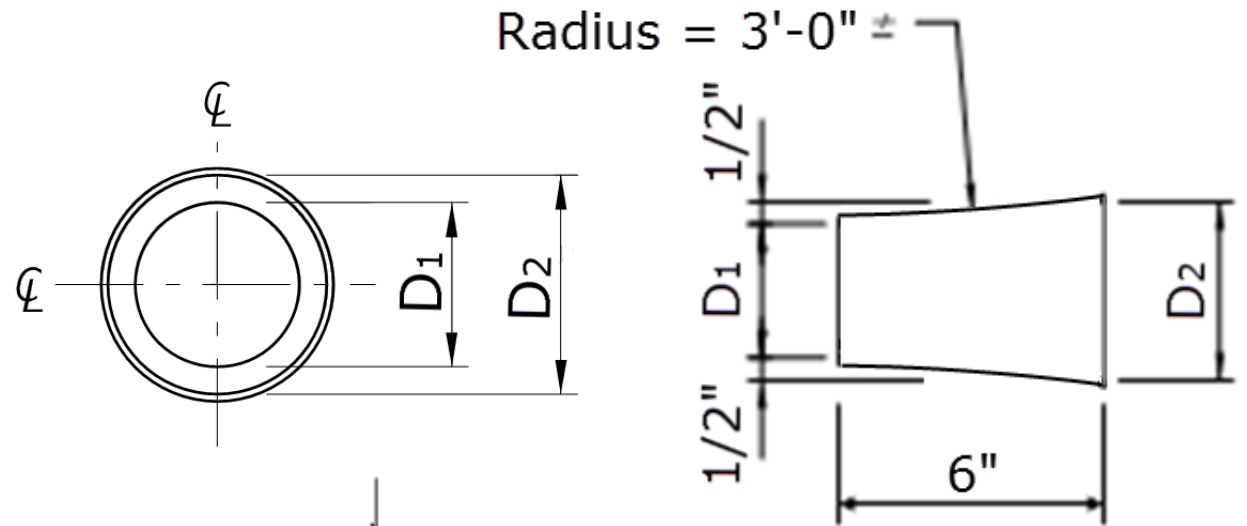
Diabolo Deviator With HDPE Duct



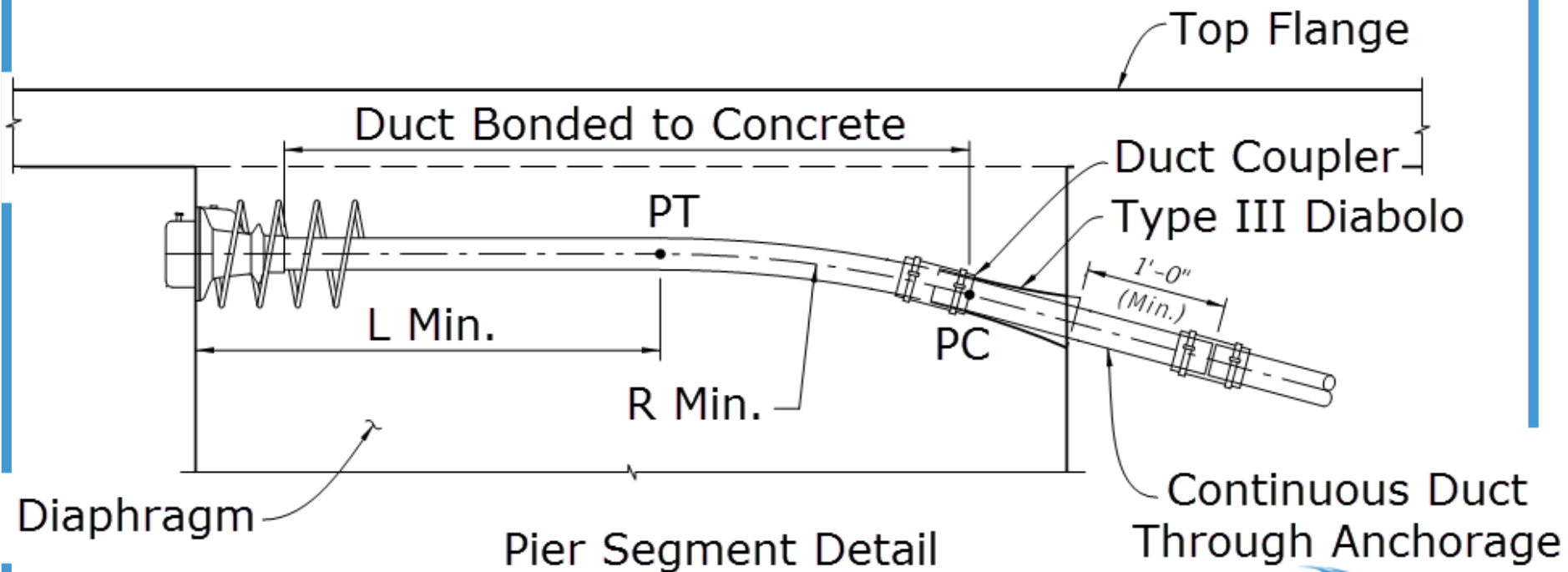
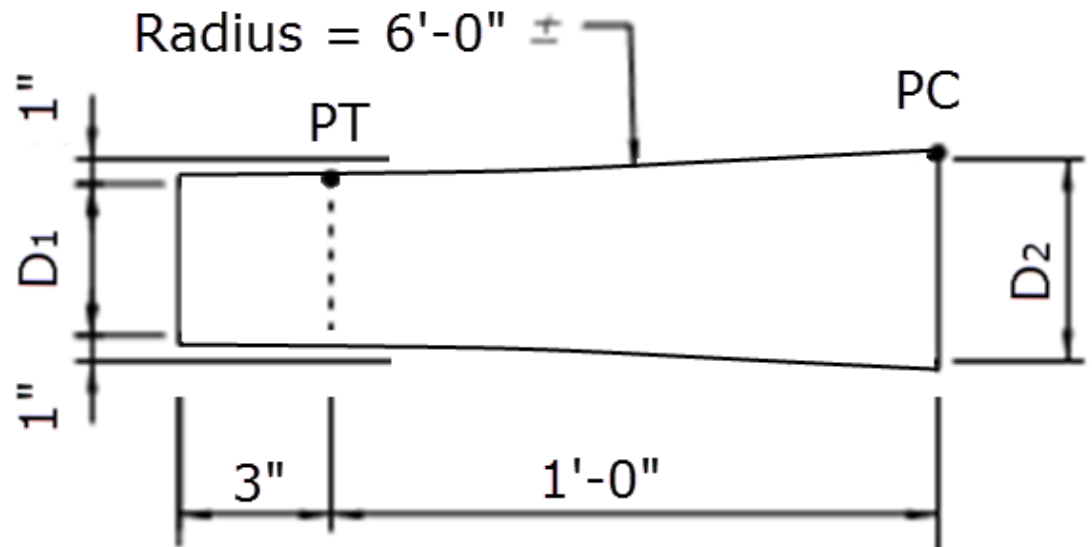
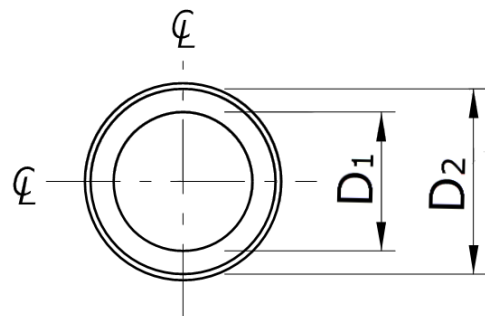
Type I Diabolo



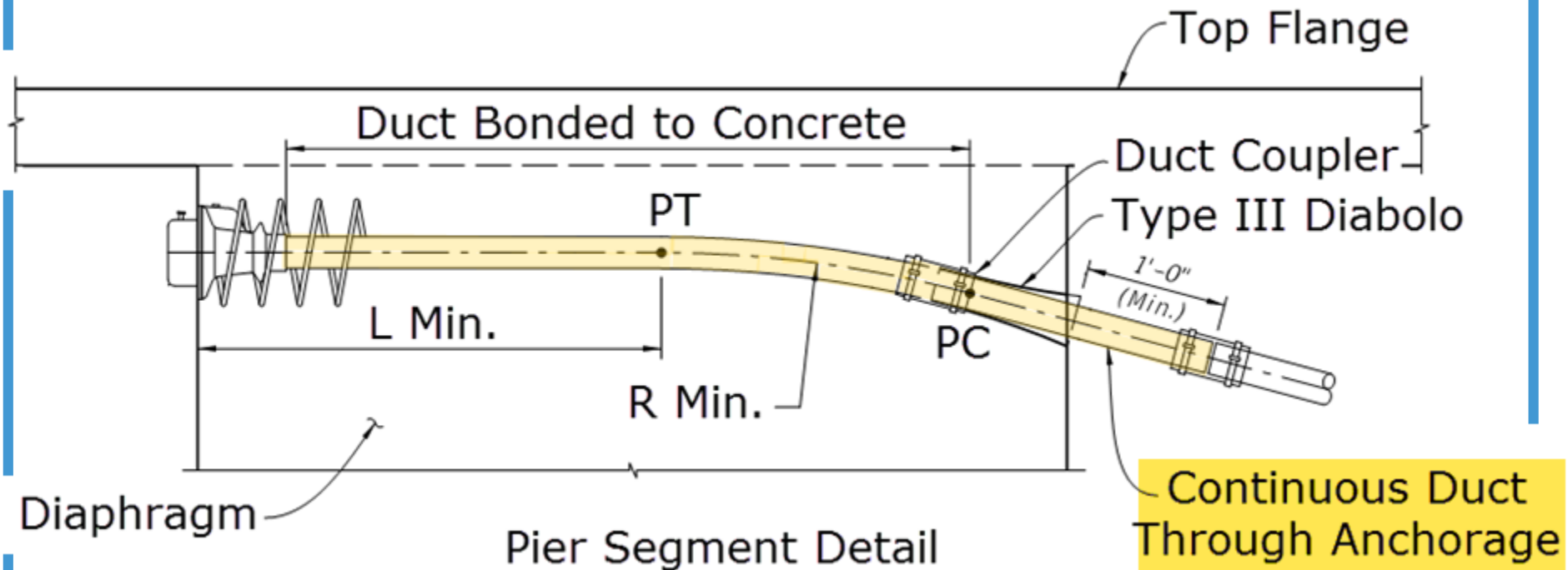
Type II Diabolo



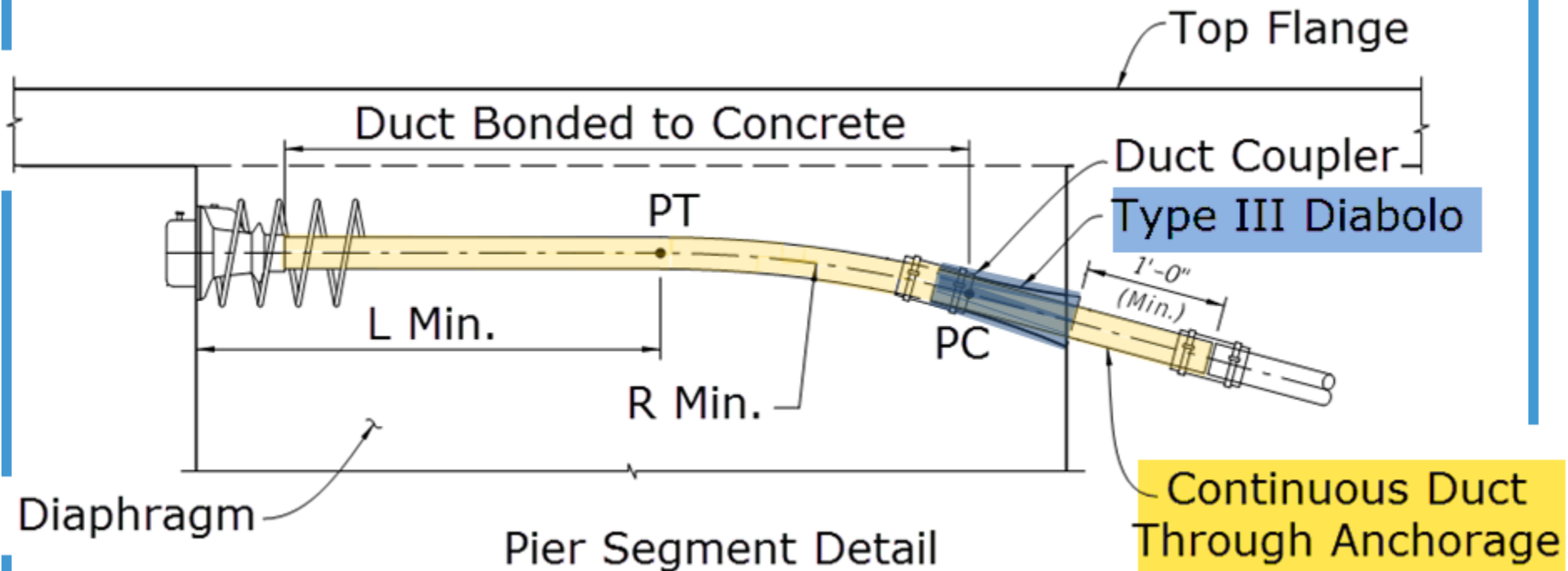
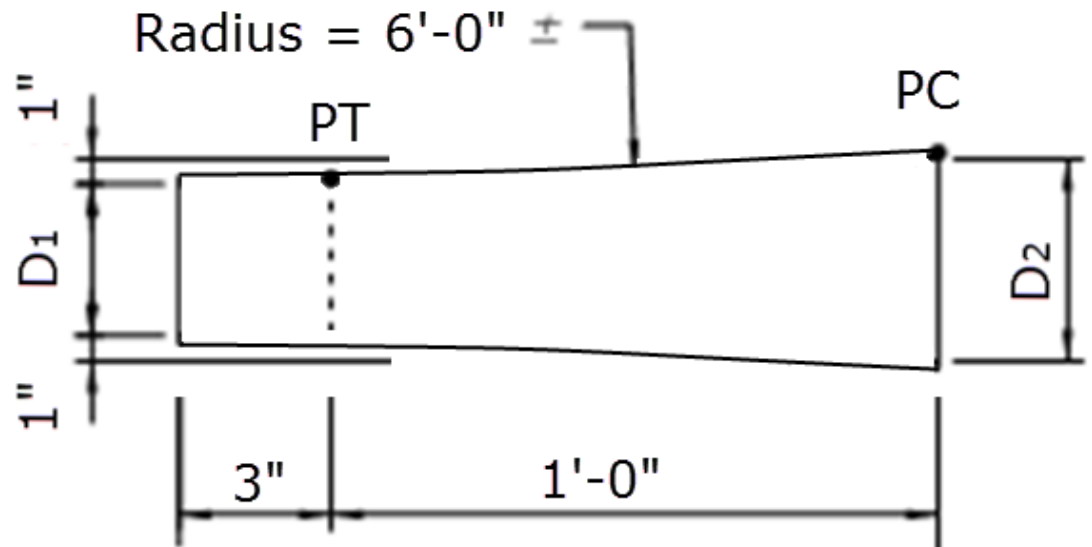
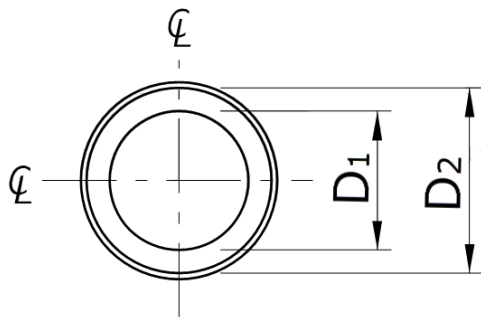
Type III Diabolo



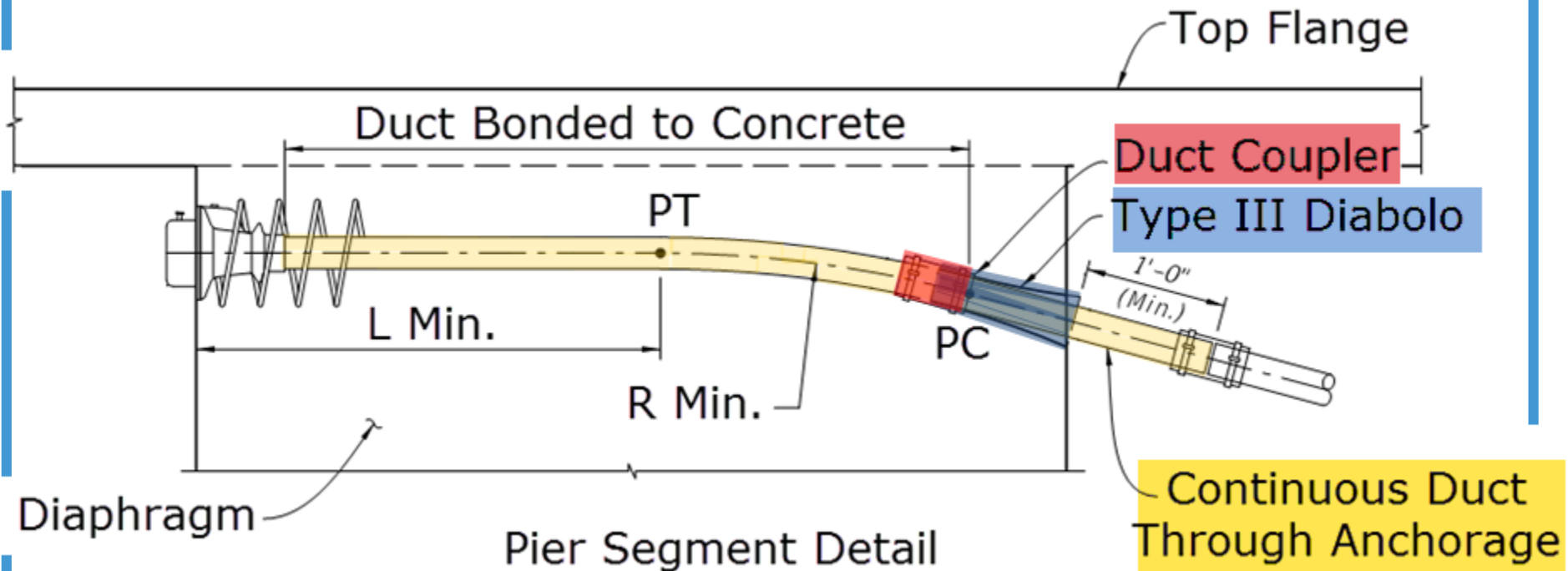
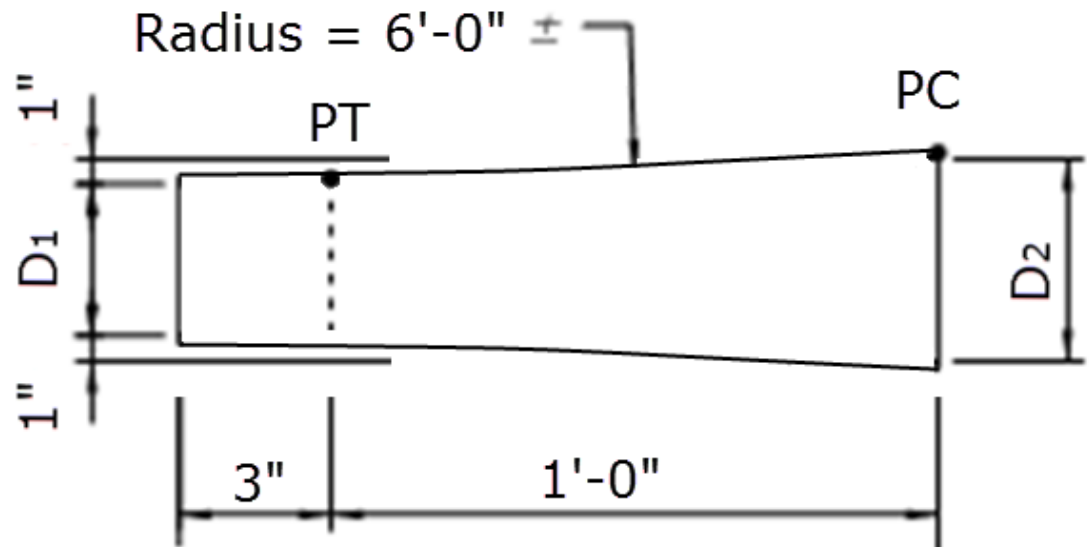
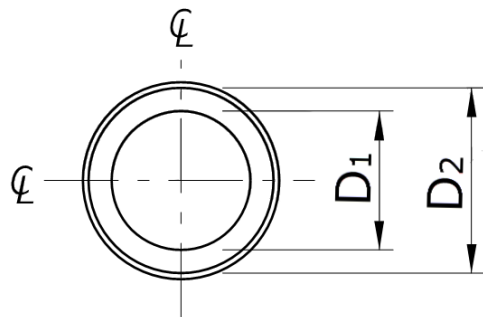
Technical drawing of a circular cross-section of a ring. The drawing shows two concentric circles. The outer diameter is labeled D_2 and the inner diameter is labeled D_1 . The drawing is oriented with a vertical centerline and a horizontal centerline, both indicated by dashed lines. The label \varnothing is placed at the top and left of the circles.



Type III Diabolo

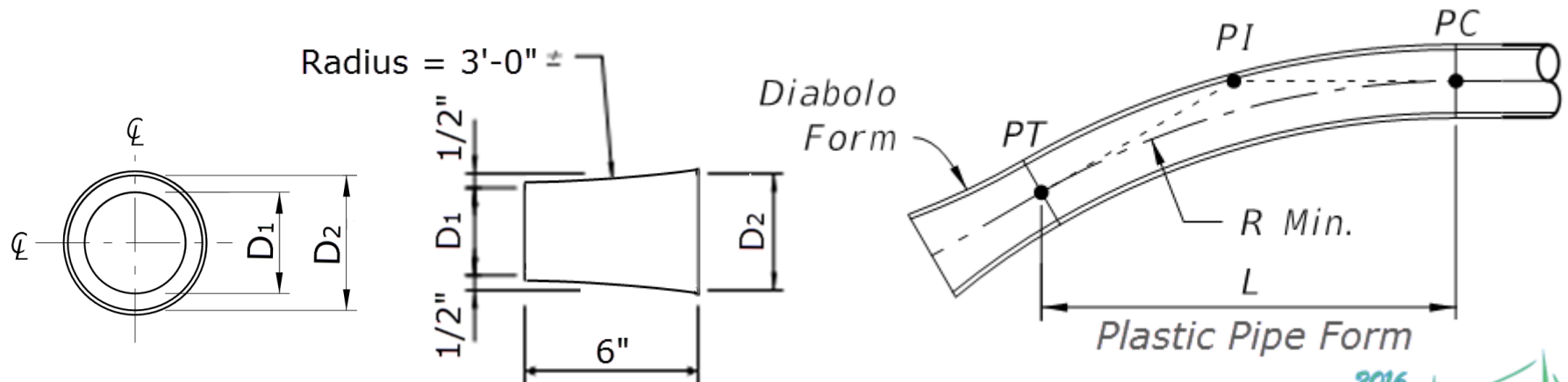


Type III Diabolo



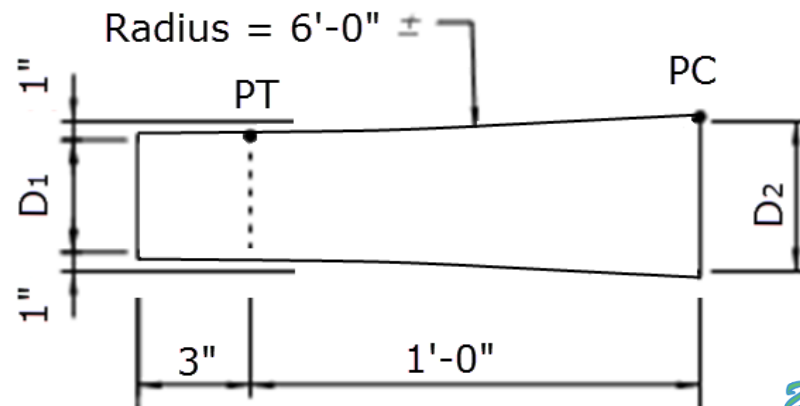
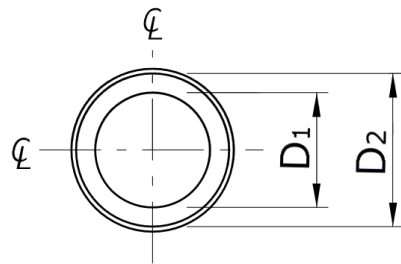
Diabolo Dimensions

POST TENSIONING COMPONENT DIMENSIONS						
TENDON SIZE	HDPE SMOOTH DUCT (DR 17) DIMENSIONS			PLASTIC PIPE FORM ID (in)	TYPE II DIABOLO DIMENSIONS	
	IPS PIPE SIZE (in)	OD (in)	ID (in)		D ₁ ID (in)	D ₂ ID (in)
7 - 0.6" Diameter Strands	3	3.500	3.063	4	4	5
12 - 0.6" Diameter Strands	3	3.500	3.063	4	4	5
15 - 0.6" Diameter Strands	4	4.500	3.938	5	5	6
19 - 0.6" Diameter Strands	4	4.500	3.938	5	5	6
27 - 0.6" Diameter Strands	5	5.563	4.870	6	6	7
31 - 0.6" Diameter Strands	5	5.563	4.870	6	6	7



Diabolo Dimensions

POST TENSIONING COMPONENT DIMENSIONS					
TENDON SIZE	HDPE SMOOTH DUCT (DR 17) DIMENSIONS			TYPE III DIABOLO DIMENSIONS	
	IPS PIPE SIZE (in)	OD (in)	ID (in)	D ₁ ID (in)	D ₂ ID (in)
7 - 0.6" Diameter Strands	3	3.500	3.063	3.625	5.625
12 - 0.6" Diameter Strands	3	3.500	3.063	3.625	5.625
15 - 0.6" Diameter Strands	4	4.500	3.938	4.625	6.625
19 - 0.6" Diameter Strands	4	4.500	3.938	4.625	6.625
27 - 0.6" Diameter Strands	5	5.563	4.870	5.688	7.688
31 - 0.6" Diameter Strands	5	5.563	4.870	5.688	7.688



Specifications

FLORIDA
DEPARTMENT
OF
TRANSPORTATION



STANDARD SPECIFICATIONS
FOR
ROAD AND BRIDGE
CONSTRUCTION

105 Personnel
Qualifications

462 Post-Tensioning
(Construction)

960 Post-Tensioning
Components

Specification 105-8.7.7.3

Flexible Filler Injection Personnel

Provide at least two CTQP Qualified Grouting Technicians, one of whom must be a Level II CTQP Qualified Grouting Technician, **both of whom must have ASBI certification in the flexible filler process.**

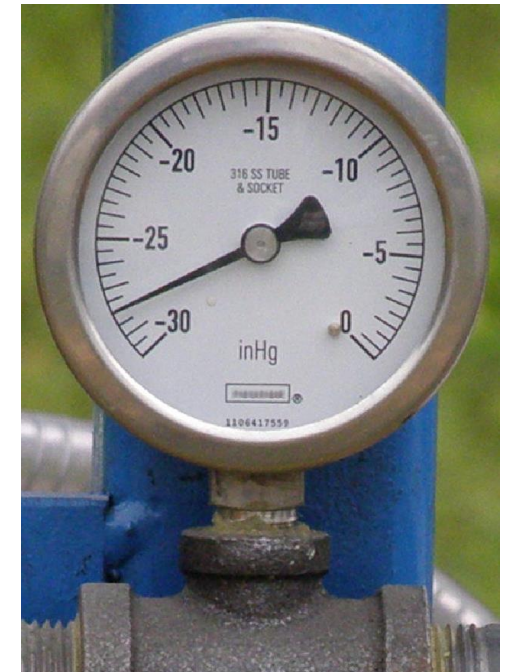
Verifiable experience performing injection of similar flexible filler on at least two projects is acceptable in lieu of ASBI certification in the flexible filler process”

Specification 462-7.4.2

Flexible Filler Operations:

- Inject flexible filler **with or without using vacuum assistance** for tendons with **vertical** or predominately vertical profiles as shown on Design Standards Index 21801.
- Inject flexible filler using **vacuum assistance for all other tendon profiles** shown on Design Standards Index 21801.

10 CFM Vacuum Pump



Specification 462-7.4.2.1.1

DRAFT
Specification
Revisions

Mock-up Requirements

Demonstrate, to the Engineer's satisfaction, wax injection of a duct by constructing full-scale mockups with all associated PT system components **using the mockup tendon profiles shown in the Plans...**

Specification 462-7.4.2.1.5

DRAFT
Specification
Revisions

Wax Injection:

1. Maintain wax temperature in strict compliance with the wax manufacturer's published product data sheet **and within the limits of this Section.**
2. Perform wax injection in accordance with procedures set forth in approved Wax Injection Operations Plan.
3. Inject **hot wax into specified** duct **inlet.**

Temperature:

Condition wax to maintain its temperature during injection between 212°F and 240°F ~~unless proven acceptable~~ **otherwise.**

Specification 462-7.4.2.1.5

DRAFT
Specification
Revisions

Wax Injection

Inject PT wax at a continuous and steady rate in accordance with the approved Wax Injection Operations Plan at a flow rate through duct at a velocity between 40 and 70 feet per minute and pressure limited to 75 psi **at the duct inlet and 145 psi at the pump.**

Specification 462-8.3.2.2

DRAFT
Specification
Revisions

Post Flexible Filler Injection Operations

If a void is detected **and the void is deeper than ½ inch or if the strands are exposed and uncoated**, address the void using this section and methods described in the approved Wax Injection Operations Plan.

Specification 960

DRAFT
Specification
Revisions

fib Technical Report, Bulletin 75

Polymer-Duct Systems for Internal Bonded Post-Tensioning

(December 2014)

Replaces

fib Technical Report, Bulletin 7

Corrugated Plastic Ducts for Internal Bonded Post-Tensioning

(January 2000)

Specification 960

Table 3.2.1-1

DRAFT
Specification
Revisions

- Dimensional Requirement
- Stiffness of Duct
- Longitudinal Load Resistance
- Lateral Load Resistance
- Flexibility of Duct System
- Leak Tightness of Duct System
- Concrete Pressure on Duct
- Wear Resistance of Duct
- Wear Resistance of Duct under Sustained Loads
- Bond Behavior of Duct
- Precast Segmental Duct Coupler System
- Leak Tightness of Anchorage-Duct Assembly
- Full Scale Duct System Assembly
- Leak Tightness of Assembled Duct System

Research

BDV27-977-10

Corrosion Prevention of Bridge Tendons Using Flexible Filler Materials

- **Principal Investigator:**

Dr. Francisco J. Presuel-Moreno
Florida Atlantic University

- **Project Manager:**

Ron Simmons
State Materials Office

Uncoated Strand

10 Days Outdoors and 20 Days in Lab



Wax & Strand Samples



BDV31-977-15

Replaceable Unbonded Tendons for Post-Tensioned Bridges

- **Principal Investigators:**

Dr. Trey Hamilton & Dr. Jennifer Rice
University of Florida

- **Research Assistants:**

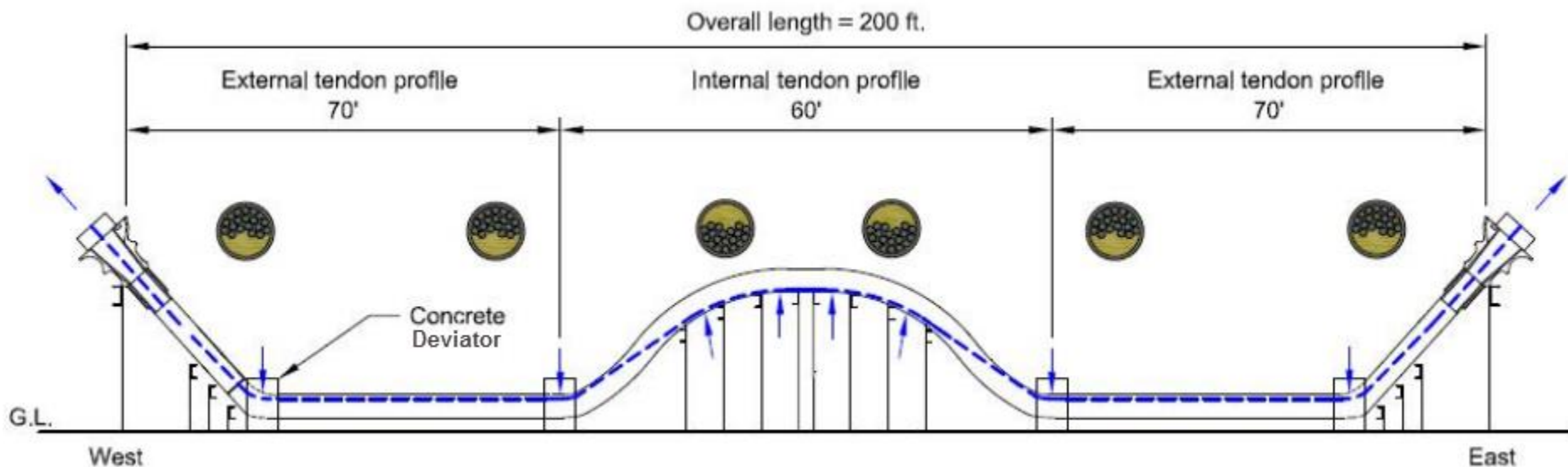
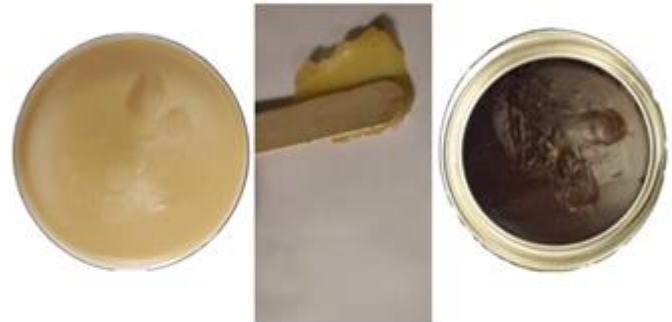
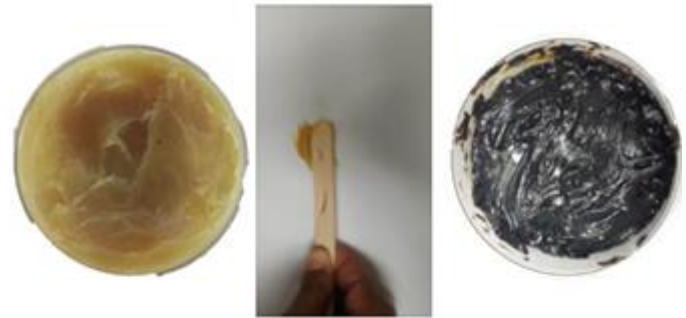
Natassia Brenkus, A.B.M. Abdullah, Rahul Bhatia

- **Project Managers:**

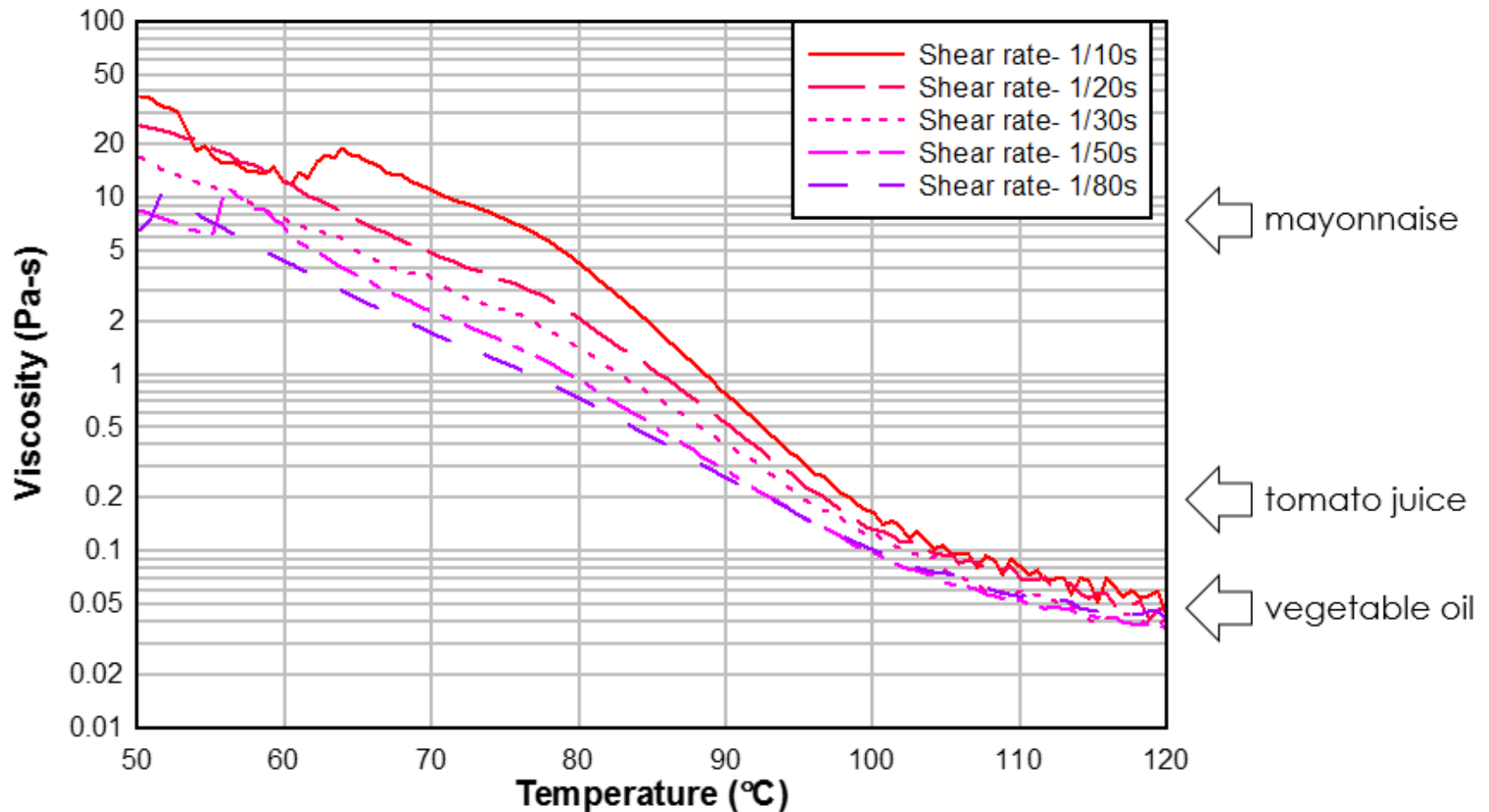
Will Potter & Rick Vallier
Florida Department of Transportation

Tasks

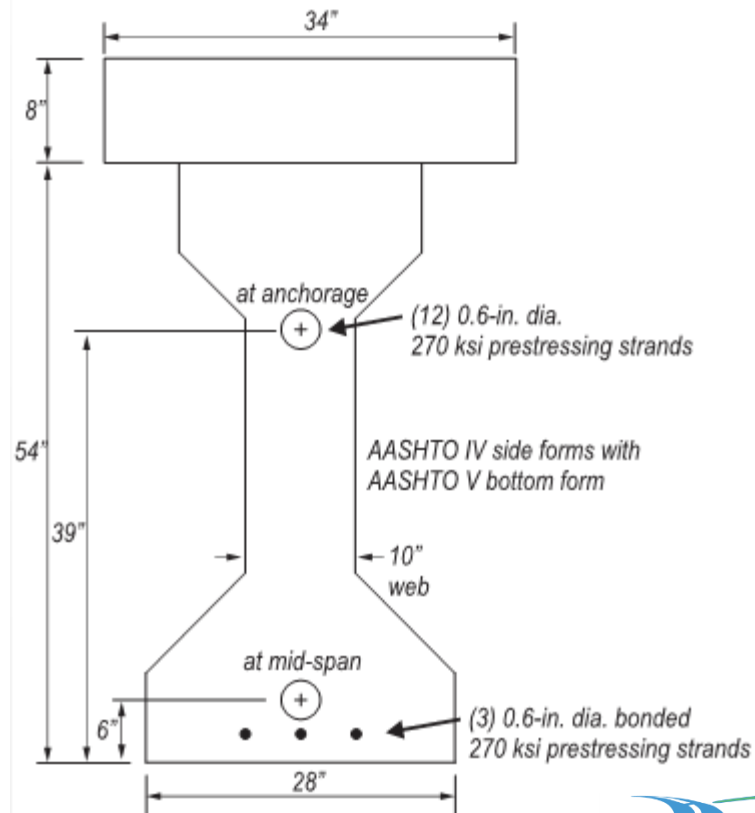
- ❑ Full-scale Mock-up Injection
- ❑ Internal Tendon Testing
- ❑ External Tendon Testing
- ❑ Final Report



Viscosity & Temperature

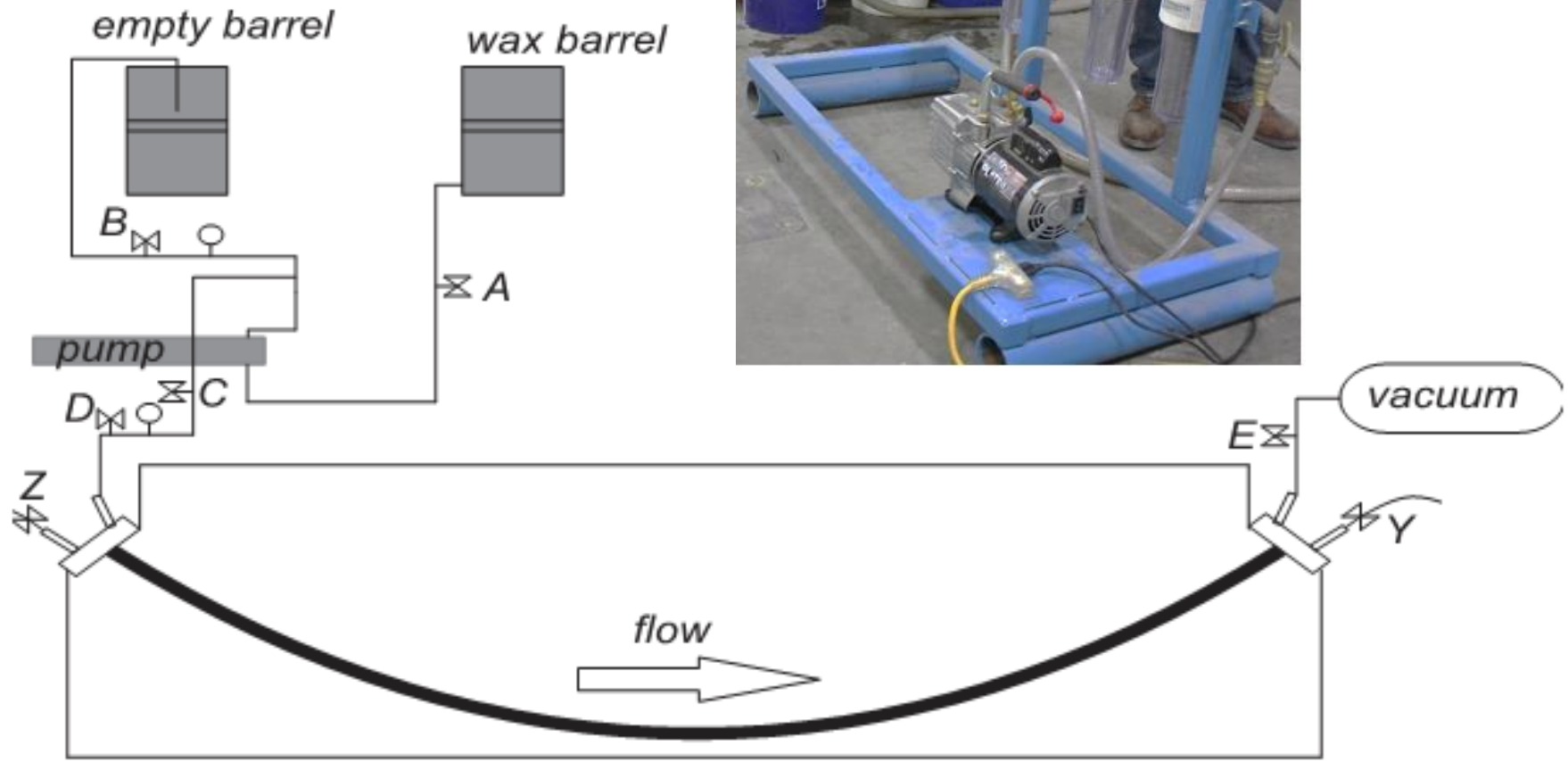


Internal Tendon

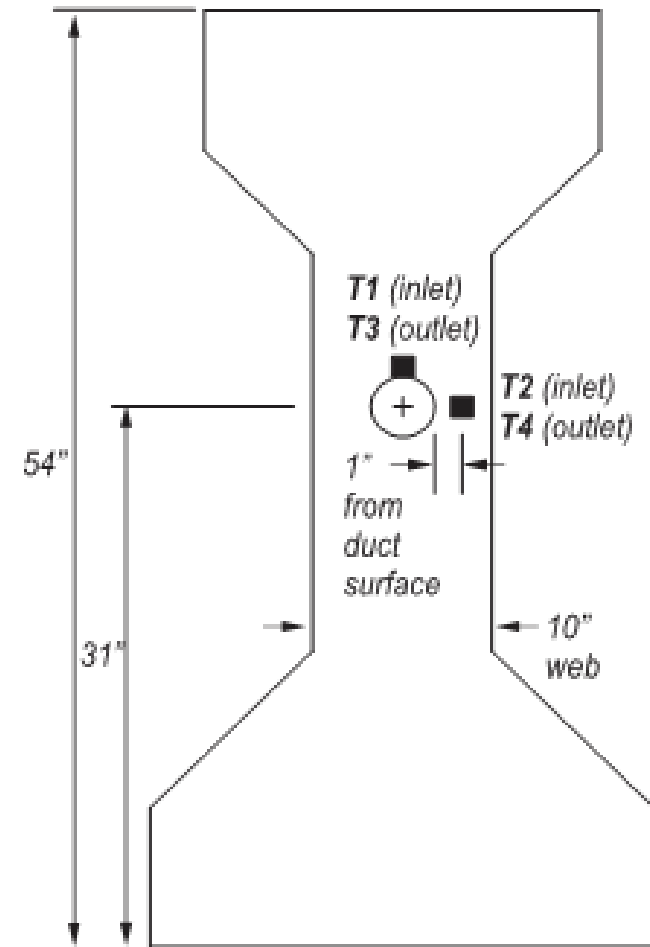
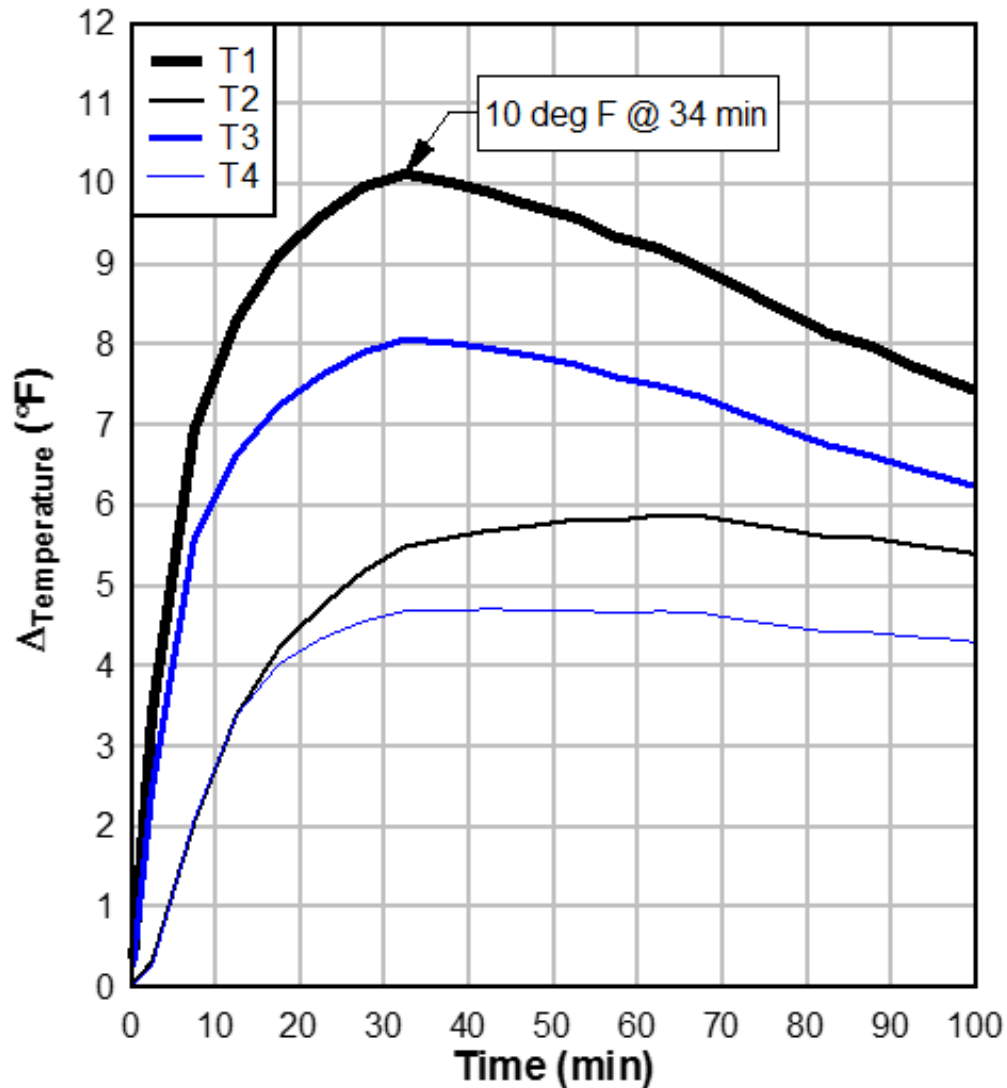


Vacuum Assist Injection

Wax (barrels): 212 °F
Ambient : 83 °F

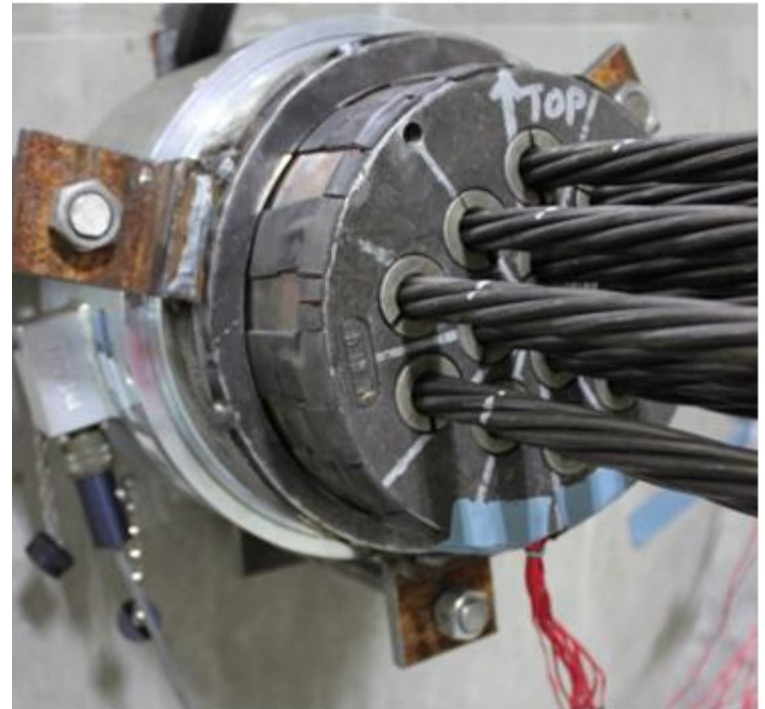
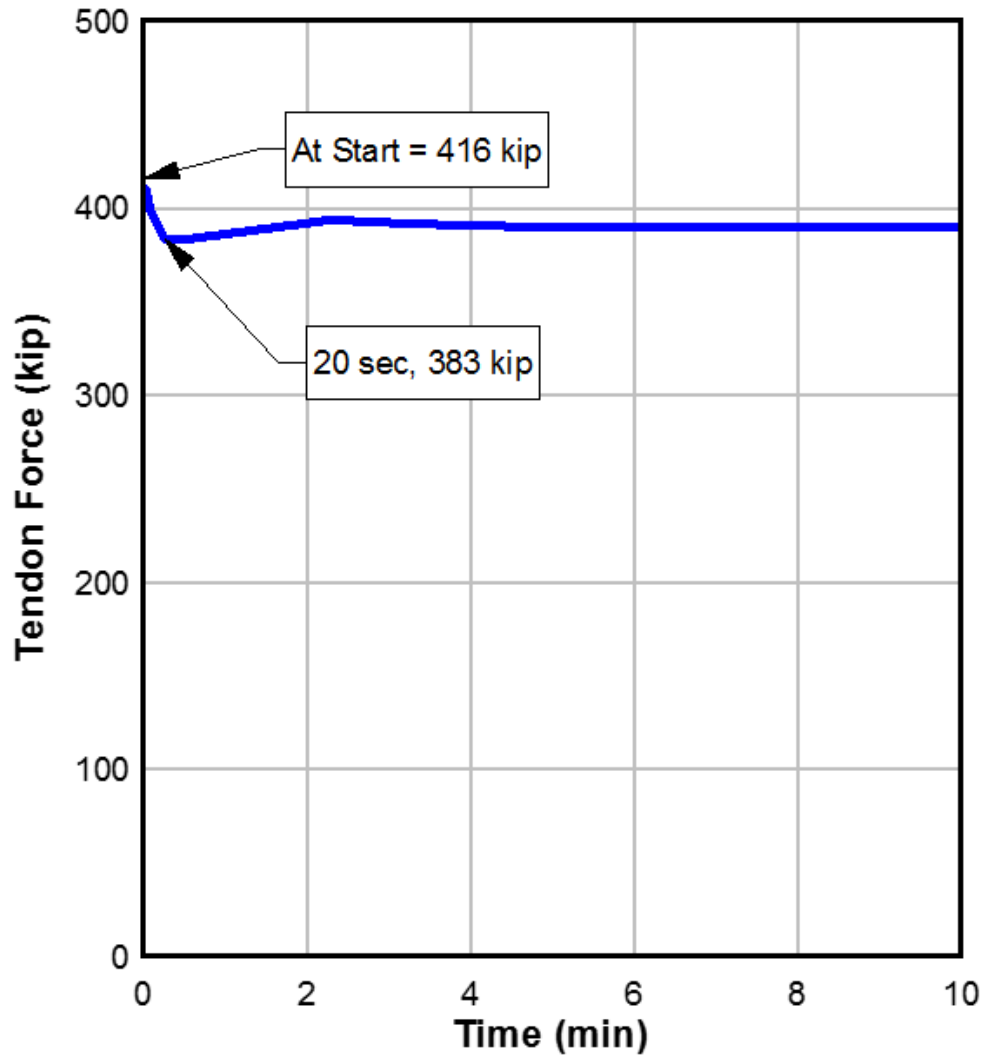


Concrete Temperature Change

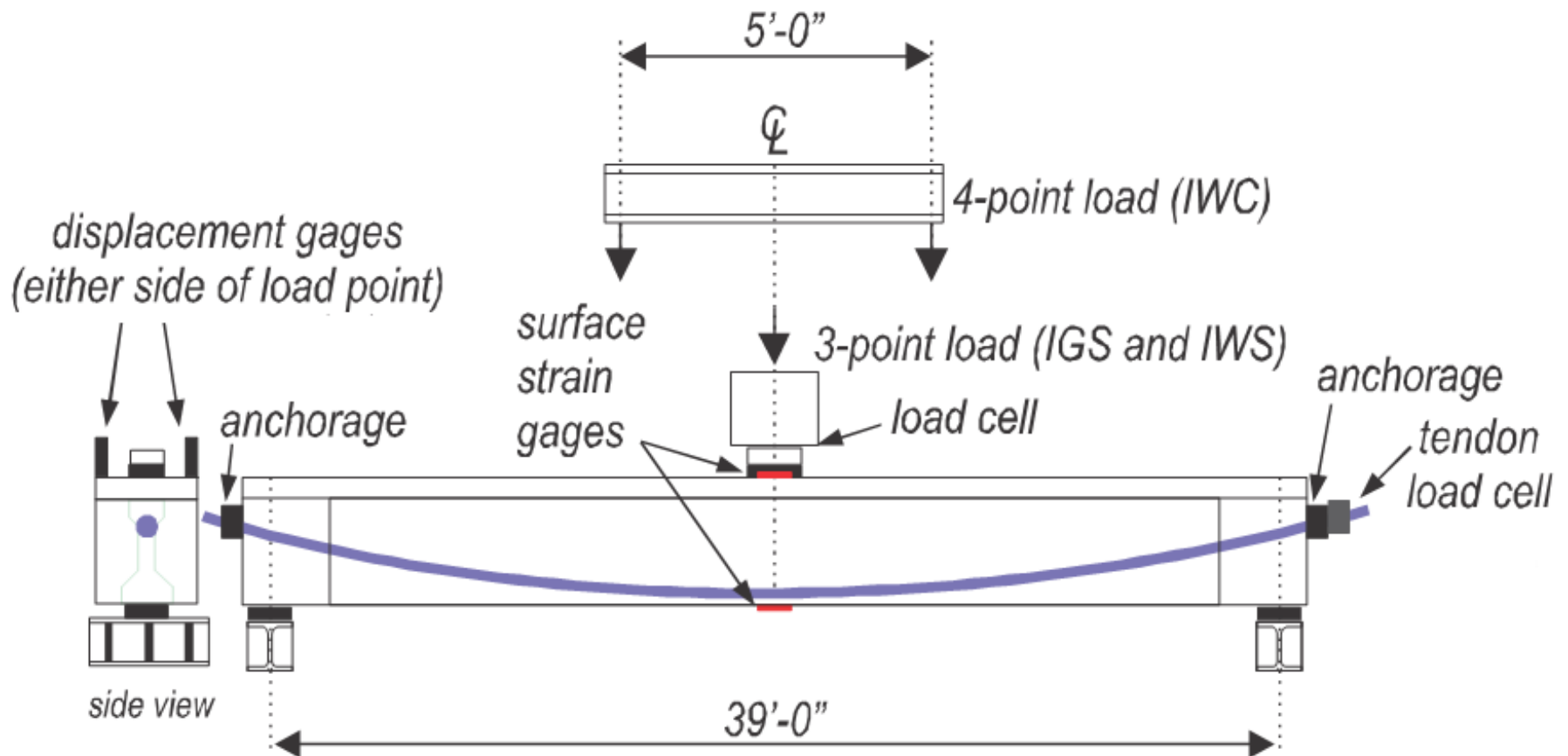


Wax Injection

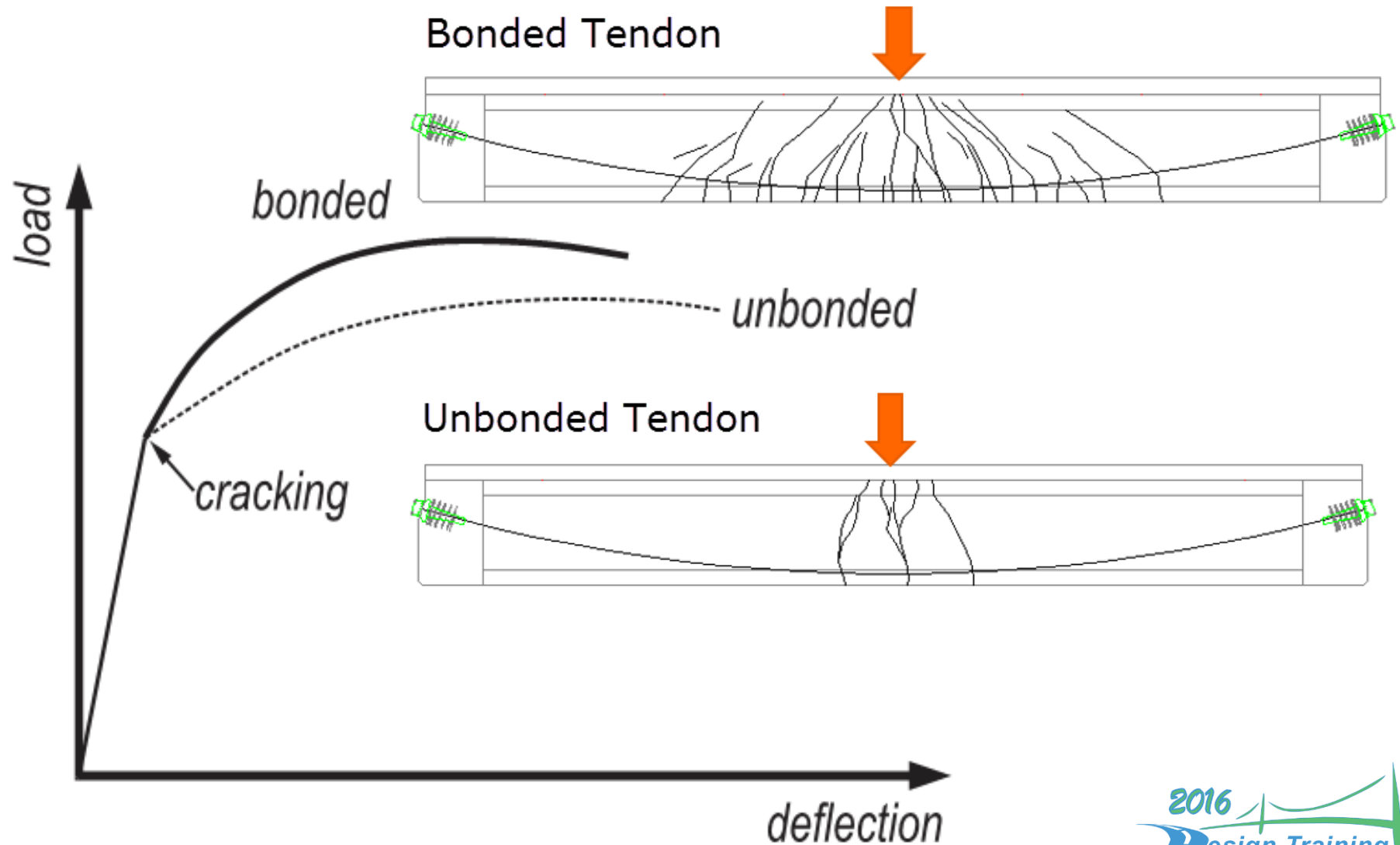
Force at start of injection: 416 kip
Approx. 7 hrs. to full force recovery



Internal Tendon Testing

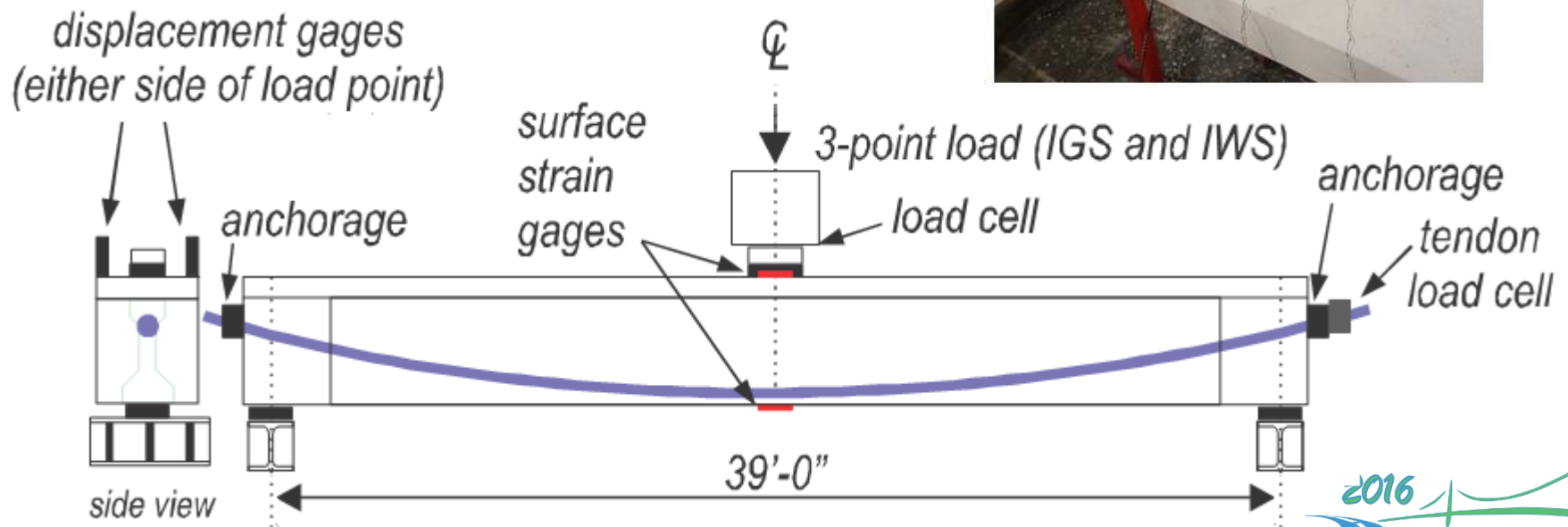


Ultimate Behavior



Ultimate Behavior

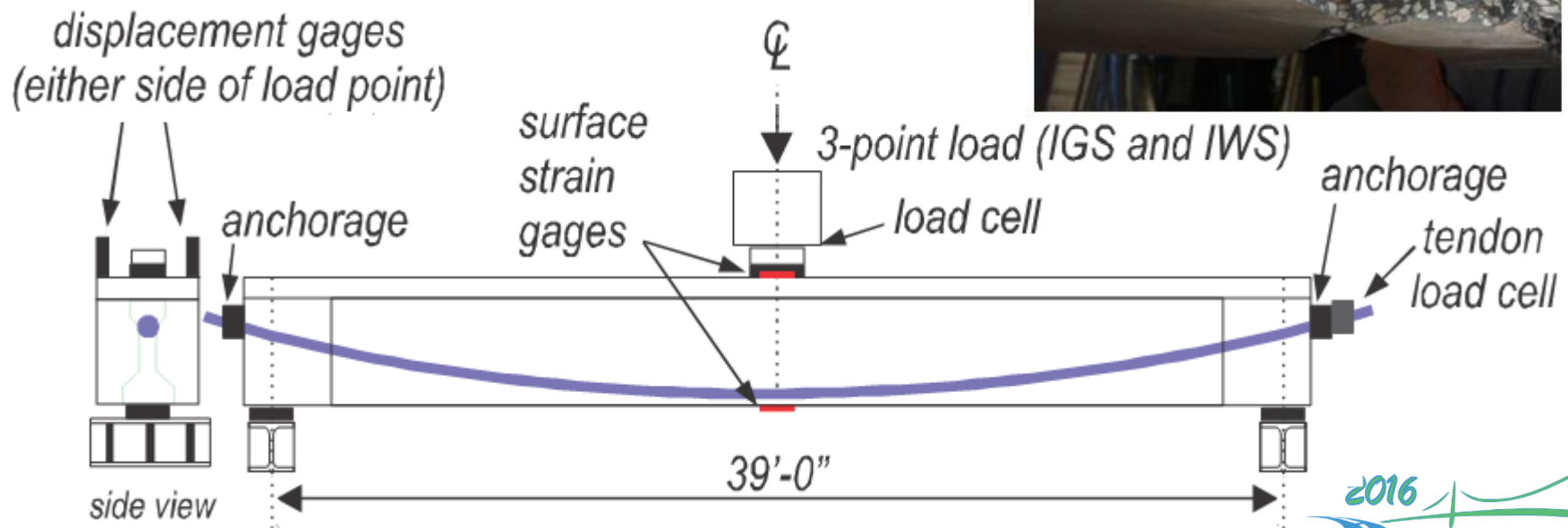
Bonded (Grouted Beam) Compression Failure at Point Load



Ultimate Behavior

Unbonded (Flexible Filler)

Rupture of the
Bonded Prestressing Steel
followed by
Compression Failure of the Deck



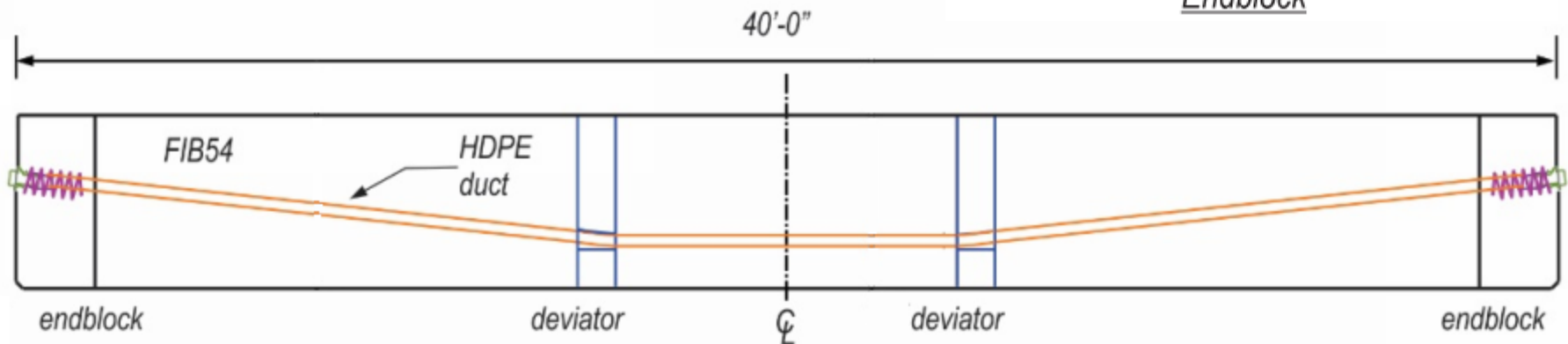
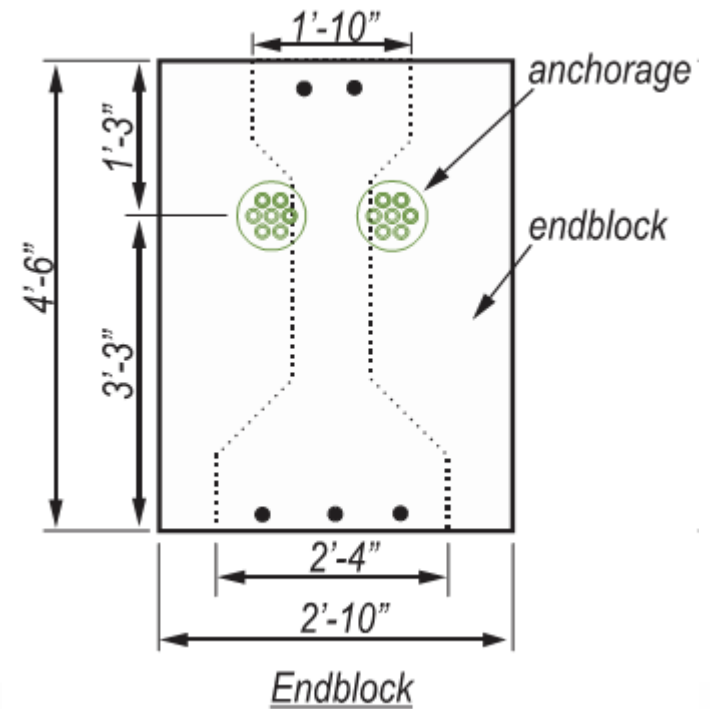
Tendon Replacement



External Tendons



External Tendon



Thank You

Rick W. Vallier, P.E.

Structures Design Engineer

Florida Department of Transportation

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